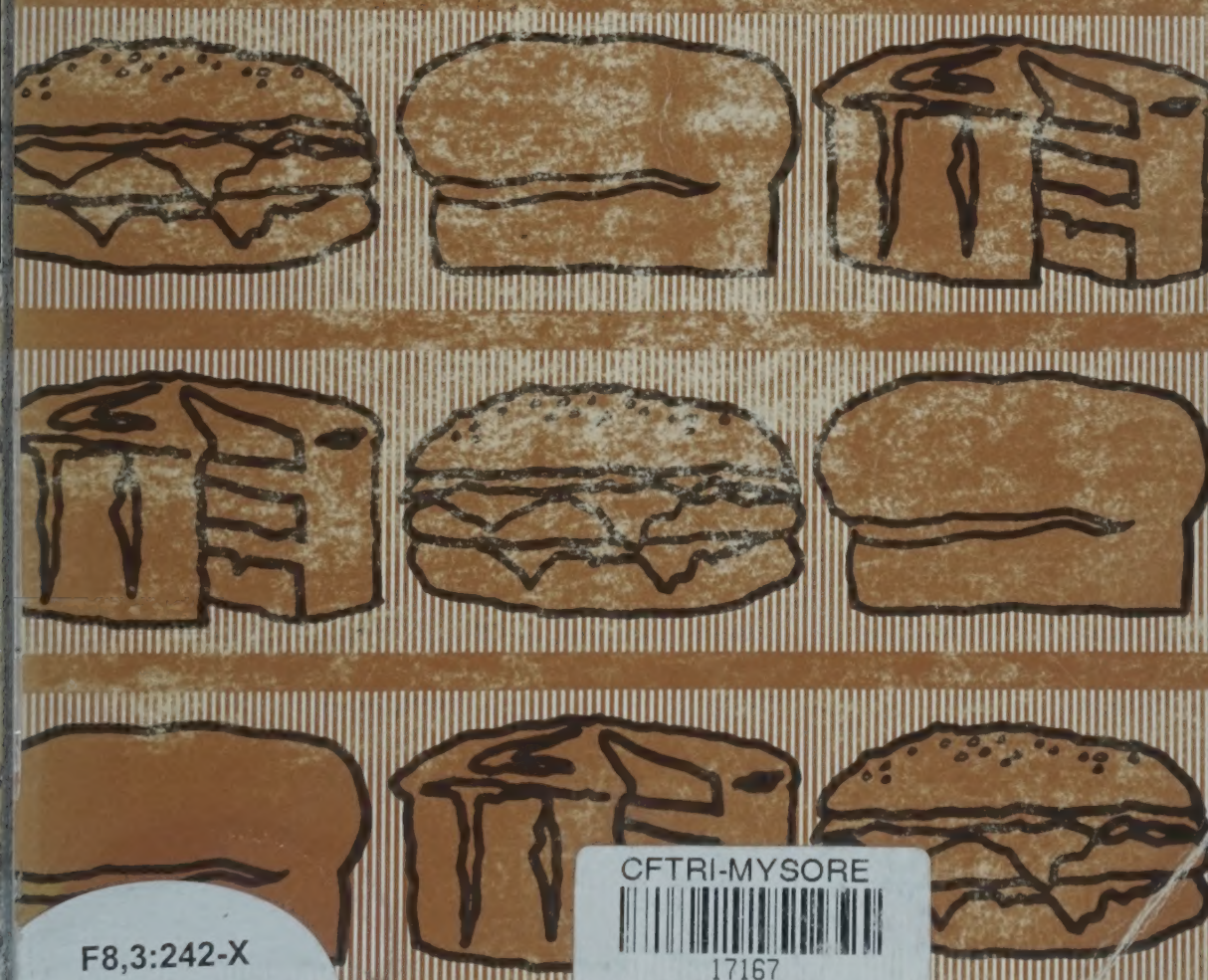
Adding Nutrients to Foods:

Where Do We Go From Here?



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Adding nutrients..

James L. Vetter, editor

Adding Nutrients to Foods:

Where Do We Go From Here?

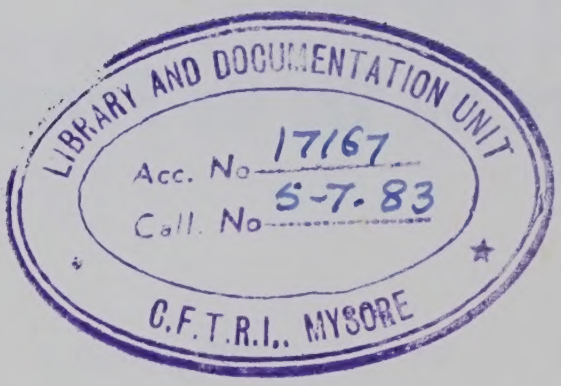
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Adding nutrients..

PREFACE

The American Association of Cereal Chemists established a Council on Fortification in the Summer of 1981 by action of its Board of Directors. The purpose of the Council is:

> "To encourage appropriate enrichment/fortification practices in order to improve the nutritional quality of diets at both domestic and international levels."

The Council anticipates that it will have a continuing series of multi-faceted programs aimed at achieving its purpose. This workshop, "Adding Nutrients to Foods - Where Do We Go From Here?", represents the first major effort of the Council.

The workshop brought together speakers with varied backgrounds, but common interest and/or expertise in the wide range of factors which must be considered in establishing or implementing policies relative to the addition of nutrients to foods: government policies and attitudes; determination of need for adding nutrients; technical feasibility considerations and the mechanics and economics of nutrient additions.

These proceedings include the formal presentations made during the day and a half workshop. The final chapter provides a meaningful and challenging summary of what was heard and what it means to cereal chemists and processors of grain-based foods.

The AACC Council on Fortification will take information from the formal presentations - as well as comments made during the stimulating discussion periods and other pertinent background information - and develop a policy statement and action program concerning the addition of nutrients to processed cereal foods.

It is our hope that this policy statement and action program will serve as rallying points around which cereal chemists can gather and from which they can move forward toward the ultimate goal of providing adequate food and nutrients to all people of the world.

James L. Vetter, Ph.D.
Chairman, AACC Council on Fortification

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Adding Nutrients to Foods:

Where Do We Go From Here?

FOOD FORTIFICATION AND THE U.S. CONGRESS

Mahlon A. Burnette, III, Ph.D.

League for International Food Education
915 Fifteenth Street, N.W.
Washington, D.C. 20005

The primary role that the U.S. Congress played in food fortification was the passage in 1938 of the Food, Drug and Cosmetic Act (FDCA). Prior to then fortification actions had been extra-governmental; since then fortification actions have been either regulatory or extra-governmental. Therefore it is important to understand what Congress created in that 1938 Act which allows for the regulation of fortification, and why Congress has not been compelled to get involved in the food fortification issue since.

The FDCA does not contain a definition of fortification nor a specific regulation for foods that are fortified. Although three provisions of the Food, Drug and Cosmetic Act have historically regulated fortification, only two were used from 1938 to 1973. The irony of the law is that all three provisions are part of § 403 (21USC343), the section on misbranding which controls labeling.

The first provision to be used was § 403(g), which establishes that misbranding has occurred when foods that purport to be "foods for which there is a standard of identity" do not, in fact, meet that standard. The second provision to be used was § 403(j), which establishes that misbranding has occurred when "foods for special dietary use" are not labeled with the "vitamin, mineral and other dietary properties of the food".

When Congress passed the FDCA, it created new authority in § 401 (21USC341), which allows the "Secretary" (at that time the Secretary of the U.S. Department of Agriculture, now the Secretary of Health and Human Services) to establish a "standard of identity...whenever, in the judgement of the Secretary, such action will promote honesty and fair dealing in the interest of consumers". This was the first time that specific authority to establish standards of identity had been written into the law. Prior to 1938 there had been food standards of identity, but they had been issued at the dis-

cretion of the Secretary, who often had to go to court and prove that the standards were reasonable, with the total burden of proof on the government. Therefore, through § 401 and § 403, the 1938 Act said:

1) The Secretary can establish standards of identity, and
2) Foods for which there is a standard of identity, that do not meet that standard, are misbranded.

These provisions allow the standards of identity to require the inclusion of nutrients, and thus control fortification of these foods through labeling, using § 403(g).

The FDCA considers foods which do not have standards of identity, but which do contain added nutrients, "foods for special dietary use", and provides for the control of labeling of such products. Again, the fortification is controlled through the labeling, since the food is misbranded if it is not labeled with the vitamins or minerals that are added, under § 403(j). Controlling what goes on the label effectively controls what goes in the product.

As mentioned earlier, before 1938, fortification actions were taken extra-governmentally, primarily by the Committee on Foods of the American Medical Association. By 1936 this committee had officially approved only two fortificants: vitamin D in milk, and iodine in table salt. Since 1938 other extra-governmental organizations and actions have been involved in the derivation of the control of fortification in this country.

In 1940 the National Academy of Science formed the Food and Nutrition Board. At the first meetings in November of 1940, the Board endorsed thiamin, niacin, riboflavin, and iron fortification of wheat flour. These were the same fortificants that appeared in the first standard of identity for enriched flour. This standard, which took effect January 1, 1942, was amended in 1943 to allow for the voluntary addition of calcium and vitamin D. In May 1941 the Food and Nutrition Board (FNB), the Food and Drug Administration (FDA), and the American Bakers Association (ABA), outside of both law and regulations, agreed to use the standard of identity for flour to create enriched bread. Enriched bread appeared soon after, although a standard of identity for bread was not actually proposed until 1943. Since the product was already in the marketplace, finalization was slow; the standard did not become effective until 1952.

Another significant event in the fortification of food, which took place outside of both Congress and the regulatory agencies, was the War Foods Administration Food Distribution

Order # 1, issued in 1942. War Order 1 required the enrichment of all white bread, specifying those same fortificants which had been informally agreed to by the FNB, FDA, and ABA the previous year. War Order 1 was subsequently extended to include white rolls.

Many of these same extra-governmental organizations are still as actively involved in the issue of fortification as are the official parts of the government. In 1973 the American Medical Association (AMA) and the Food and Nutrition Board issued a food fortification statement. In 1981 the AMA and the FNB agreed on a revision of the fortification statement. (This revision is scheduled to be printed in Nutrition Reviews this year.)

In discussing what Congress did in 1938, and how fortification has been controlled without the addition of new laws or new activities by Congress, it is important to point out that most fortification today is not strictly controlled by the mislabeling section for "foods for special dietary use", § 403(j), or for "standards of identity" foods § 403(g).

Today, without any change in the law, FDA uses another section of FDCA, § 403(a). In 1973 Nutrition Labeling took effect, with FDA using this provision of the FDCA to require foods with added nutrients to satisfy the nutrition labeling regulations, listing all of the mandatory nutrients in order to be properly labeled. This avoids the need to establish specific "foods for special dietary use" regulations for those foods which meet the standards of nutrition labeling. Therefore, if you add a nutrient, or make a nutrient claim, you need only to properly nutrition label the food.

This provision of § 403 is different from the two discussed previously, (each of which pertains to a specific type of food), since § 403(a) states that food is misbranded if the labeling is "false or misleading". The standard for mislabeling is the failure to reveal a "material fact". The legal logic is:

1) If you add a nutrient, you must claim it, and
2) If you claim it, and list amounts of all other required nutrients, you have properly described the product.

With these three provisions, § 403(a), (g), and (j), passed by the Congress in 1938, FDA has found ways of controlling fortification without further action by Congress. However, in 1974, FDA proposed "General Principles Governing the Addition of Nutrients to Food". Since then, the FDA General Counsel's Office has determined that under current law products cannot be banned from the marketplace simply be-

cause they are inappropriately fortified. Nutrients that a added to foods are considered safe, either by being on the GRAS list, or on the regulated food additives list. Therefore, not withstanding the power of the three provisions of the FDCA already discussed, it may not be possible for FDA write blanket regulations controlling fortification.

In some instances, where there are toxicological problems with nutrients, such as selenium or calcium, FDA has either ignored the problem or written regulations around the problem. The courts and the Congress have shown a great reluctance to allow FDA to strictly control nutrients over the last six or seven years. Therefore, in January 1980, the final action was taken in this area with the publication of the guidelines, "Nutritional Quality of Foods: The Addition of Nutrients". Guidelines do not have the full force and effect of law.

Although Congress has not had fortification on its agenda since 1938, it has considered closely allied issues. In the vitamin/mineral amendments (the Proxmire amendment) to the FDCA in 1976, Congress created § 411. This section prohibits the Secretary from limiting the combination, number, or potency of vitamins or minerals, with the exception of products intended for use by children and pregnant or lactating women, or for the treatment of specific diseases. In addition, products may not be found to be misbranded only because they contain combinations or levels of vitamins or minerals which FDA does not like. Nor can the Secretary conclude that these products are drugs simply on the basis of the potency or the levels of vitamins or minerals added to foods. Since this section is currently limited in its applicability to tablets, capsules, or liquid it applies only to vitamin/mineral supplements. However, there is currently extant in the Congress a bill, S.1277, introduced by Senator Orrin Hatch, Chairman of the Senate Labor and Human Resources Committee, which would expand the Proxmire amendment to restrict the authority of FDA to regulate vitamins and mineral as over-the-counter drugs or food additives.

S.1277 would add two sections to § 201 (21USC321), the definition section of FDCA. § 201(s), which defines food additives, includes a list of things which may not be considered food additives. S.1277 would add to the list of things which may not be food additives:

> "the food itself, combination of foods, or foods for special dietary use, or ingredients thereof, unless being used as preservatives or flavors of a food".

§ 201(g) is the definition for drugs, and includes thos

things which the law will not allow to be considered as drugs. S.1277 would add:

> "foods for special dietary use, when offered or employed for purposes as defined in § 411(c)(3) of this act for preservation or treatment of dietary deficiency conditions, shall not be classified as drugs".

§ 411 is the section of FDCA that the Proxmire amendment added, and § 411(c)(3) includes:

> "foods which are for special dietary use, supplying a special dietary need that exists by reasons of physical, physiological, pathological or other condition, including but not limited to, the condition of disease, convalescence, pregnancy, lactation, infancy, allergic hypersensitivity to food, underweight, overweight, or the need to control the intake of sodium, supplying a vitamin, mineral, or other ingredient for use by man to supplement his diet, or supplying a special dietary need by reason of being a food for use as the sole item of the diet."

It is difficult to imagine a food with added nutrients which would be outside this definition.

There are two other pieces of current legislation which could pertain in some way to fortification. The first is the Food Safety Bill, S.1442, also introduced by Senator Hatch, which would establish two segments of FDCA that could be important. One would create a "basic or traditional food" category, which would be exempt from most regulations. For now, that is written to include only raw agriculture commodities or moderately processed raw agriculture commodities. But, if essential nutrients were added, and thus put outside of most of the provisions of FDCA, that could be significant.

In addition, S.1442 would expand § 406 (21USC346) of FDCA to allow for tolerances in foods for food ingredients which do demonstrate a significant risk, but for which there is no reasonable substitute. This would include all essential nutrients, not withstanding evidence of carcinogenicity or other toxicity, since there is no alternative for an essential nutrient.

Finally, there is the sodium labeling bill, the Smith Gore Bill (H.R. 4031), which would require the identificat of sodium content in foods, and would allow for some attem to limit the sodium addition to foods. Given the move to voluntary sodium labeling this bill may languish for lack interest.

In the area of fortification, it is the expressed int of the current Congress to continue to limit the involveme of the Food and Drug Administration and the United States partment of Agriculture in restricting the addition of vit mins and minerals to foods, or in the production of vitami mineral supplements, or in any other controls over essenti nutrients. I predict that this situation will continue in the foreseeable future.

CURRENT POLICIES AND ATTITUDES OF GOVERNMENT TOWARD NUTRIENT ADDITIONS -- A FOOD AND DRUG ADMINISTRATION PERSPECTIVE

Allan L. Forbes, M.D.

Associate Director for Nutrition and Food Sciences
Bureau of Foods
Food and Drug Administration
Washington, D.C.

Let me start off by stating some personal views. I am, and have been for a long time, an advocate of the rational addition of nutrients to foods, or food fortification, for five basic reasons:

(1) One is the matter of simple survival in the developing world. In isolated examples, fortification has been clearly demonstrated to have a dramatic effect on combatting the pandemic of malnutrition in these countries. Even though it may not be possible to reach all of the afflicted population, huge proportions can be reached in a feasible manner. The slowness with which this has caught on in the developing world amazes and discourages me. The AACC and the related basic staple industry in the U.S. are in a good position to do something about it, and I dearly hope they will.

(2) Secondly is the matter of maintaining the nutritional quality of our national food supply. In essence, this is primarily the business of conventional fortification of basic staples and products directly derived from them such as enriched bread and breakfast cereals, whether this be straight-forward restoration of nutrients lost in processing or on some other sound nutritional basis, and the business of assuring the nutritional quality of substitute foods, or, if you wish, the avoidance of nutritional inferiority to avoid in turn designating foods as "imitations."

Note: The views expressed in this paper are those of the author, and may not reflect those of the Food and Drug Administration or the Department of Health and Human Services in all respects.

(3) Thirdly is the flexibility in nutrient composition provided by fortification when public health needs indicate the desirability of such modifications. For example, subject areas now being considered are the impacts of declining total caloric intakes, particularly among the elderly, and what we will learn over the next several years about iron, zinc and folate nutriture from detailed analysis of the data from the Second National Health and Nutrition Examination Survey (NHANES-II).

(4) Fourth is the simple fact that only through fortification can we have formulated products such as infant formulas, hospital tube feeding and other enteral products, and modifications of these foods to meet the nutritional needs of individuals who have very specific and often catastrophic disorders.

(5) And, last but no means least, fortification is cheap.

Let me hasten to add two points however. First is the idea that food fortification is not an alternative to anything except in the case of formula products. It is simply an adjunct, and a very useful one, for maintaining or improving the nutritional quality of the food supply. And secondly, I abhor the abuse of fortification, whether this be super-fortified cereal products or the whole concept of mega-vitamin, mega-anything intakes.

Turning to FDA's position, the most important point I can make today is to simply remind you that FDA published its fortification policy in the Federal Register two years ago on January 25, 1980 in a document entitled "Nutritional Quality of Foods -- Addition of Nutrients," which has been codified in the Code of Federal Regulations as Section 104.20 in Title 21. In the interim period, nothing has happened to change this policy. If anything, it has been strengthened under the current Administration because it is fundamentally voluntary and serves as our basic guide to industry in the practice of modern rational nutrition science. My own opinion is that it serves as a model which could and may well be used to build policies addressing the whole subject of the nutritional quality of our food supply and even a national nutrition policy.

Let's quickly have a look at what our food fortification policy says.

First are the basic principles which state in essence that:

(1) Nutrients may appropriately be added to a food to correct a dietary insufficiency recognized by the scientific community to exist and known to result in nutritional deficiency disease if: (a) sufficient information is available to identify the nutritional problem and the affected population groups, and the food is suitable to act as a vehicle for the added nutrients, and (b) the food is not the subject of any other Federal regulation for a food or class of food that requires, permits, or prohibits nutrient additions.

(2) It is inappropriate to fortify fresh produce; meat, poultry or fish products; sugars; or snack foods such as candies and carbonated beverages.

(3) The policy is based on U.S. dietary practices and nutritional needs, and may not be applicable in other countries.

The second part of the policy addresses technical aspects of the added nutrients, specifically stating that a nutrient added to a food must be:

(1) Stable in the food under customary conditions of storage, distribution and use.

(2) Physiologically available from the food.

(3) Present at a level at which there is reasonable assurance that consumption of the food containing the added nutrient will not result in an excessive intake of the nutrient.

(4) Suitable for its intended purpose and otherwise in compliance with relevant laws and regulations.

The third part of the policy lists reasonable approaches to fortification which include:

(1) Restoration of nutrients lost in storage, handling or processing.

(2) Addition of nutrients to substitutes for traditional foods to avoid nutritional inferiority.

(3) Addition of nutrients in proportion to the total caloric content of the food.

4) Addition of nutrients as permitted or required by

existing regulations, e.g., for enriched flour or to comply with a nutritional quality guideline for a specific class of foods.

Although the policy focuses on the general food supply, it obviously is also appropriate to add nutrients to certain types of foods for special dietary uses, e.g., infant formulas, dietary supplements and a wide variety of "medical foods."

Let me now change the subject to the international scene, specifically to the International Union of Nutritional Sciences (IUNS) and to the Joint FAO/WHO Codex Alimentarius Commission (the Codex). A recent event involving fortification and these two international organizations has occurred which I thought might be of interest to you. Many FDA nutrition staff members are involved with these groups as part of their official duties, and the U.S. adheres to both by international agreements. That does not mean that everything these groups do becomes formal U.S. policy, but I think it is fair to say that there is a strong relationship between U.S. policy and policies developed by these international organizations. In the area of food fortification, I see no inconsistencies at all. To get on with my point, I am Chairman of the Committee on Food Standards of the IUNS which is advisory to WHO, FAO and the Codex. In May in London, England, my Committee met and held a Workshop on Nutritional Quality in Food Standards and Guidelines. This led to a formal report, officially adopted by IUNS, transmitted to the Codex Commission in June, and recently published by the United Nations University (UNU Food and Nutrition Bulletin, 3: (No. 4, October), 1981, 51-53). The Workshop resulted in a set of General Principles for the Nutritional Aspects of Standards and Guidelines; several of which specifically address fortification:

1. Food fortification to counteract serious and widespread deficiency problems is a highly appropriate practice. The vehicle(s) chosen must be widely consumed by the target population, even if, in other settings, the vehicle might be considered as inappropriate, e.g., for certain countries or population groups, salt and sugar may be fully reasonable vehicles.

2. Restoration of nutrients lost in processing is an appropriate measure.

3. When substitute and/or imitation foods become a

significant portion of national and/or regional food supplies and when significant segments of the population do or reasonably may consume such foods as a major portion of the diet, it becomes advisable to fortify such foods in a manner commensurate with the nutritional quality of the foods being substituted or imitated. There is a need for development of agreement internationally on the meaning of "nutritional equivalency" and subsequent development of equivalency guidelines.

There are three other IUNS General Principles which have some relevance to food fortification which might be of interest to you:

. Nutritional quality is an integral part of overall food quality. When the nutritional quality of individual foods is considered collectively in the context of the total diet, such considerations become a matter of food safety. For example, if the nutritional quality of a nation's food supply should deteriorate, the matter of nutritional quality becomes a fundamental public health and safety issue threatening societal well-being.

. There are no "bad," "poor" or "junk" foods per se. There most assuredly are "bad," "poor" or "junk" diets, depending on the totality of the individual foods and their quantities comprising the daily diet. It is important to recognize that a specific food may be considered as a relatively undesirable component of the daily diet in one part of the world, whereas the same food may well be a particularly important dietary component elsewhere, e.g., when the food is a major energy source in an energy-deficient region or population segment.

. There is a need for greater and renewed attention to minimizing nutrient losses by food processing, e.g., in the extraction of flour. However, societal wishes and desires relative to foods and their quality cannot and should not be disregarded. Efforts should be maintained or improved to ensure ready availability of foods subjected to the minimum possible processing. It is reasonable to conclude that this would have a salutory effect on nutritional health.

These IUNS General Principles were well received by the Codex Commission meeting last June and July in Geneva. I think it is fair to say that a major increase in interest in nutritional quality is evolving at the international

level, particularly in Codex -- a very positive move in my opinion. Over the next several years, the IUNS Committee Food Standards intends to carry the process ahead by developing nutritional quality guidelines for commodity-specific and subject-specific committees and other groups working on food standards and guidelines.

Another area of major concern on the international scene is the matter of possible interference with mineral absorption by cereal and legume protein sources, sparked particularly by the recent clinical research observations of major decreases in non-heme iron absorption in the presence of soya protein in the meal. FDA, along with USDA, the Department of Defense (DOD) and the Agency for International Development (AID), is currently supporting the work of a special international Cereals and Legumes Subcommittee of the International Nutritional Anemia Consultative Group (INACG), chaired by Dr. Peter Dallman of the University of California - San Francisco.

INACG is advisory to AID, WHO and developing countries on request, and the special Subcommittee is charged with developing a state-of-the-art review of the effects of plant-derived protein sources on essential mineral bioavailability, plus conclusions, applied recommendations and recommendations for future research. Although the final Subcommittee Report will not be completed until about June 1982, the Subcommittee did present an overview of its work to date at the annual INACG meeting held last month in Santiago, Chile.

In their final report, they will consider both substitution of animal foods with soya and other plant-derived products, and the use of such products as supplements in infant feeding. It remains to be seen what their final recommendations will be, but I suspect they will address the matter of fortification of these types of foods. A highly significant new concept into the practical world of fortification has been raised in this connection i.e., the deliberate -- and highly appropriate -- use of enhancers of mineral absorption. Not only does ascorbate markedly enhance non-heme iron absorption, but so do such substances as citrate, hemoglobin, lactoferrin and probably succinate. Further research will no doubt reveal other enhancers as well as enhancers for minerals other than iron.

Returning to the domestic scene, I wanted to let you know that FDA, in cooperation with the National Center for

ealth Statistics (NCHS), has set up an informal group alled the NHANES Users Group -- a "gathering" of people rom academia, industry and government all of whom are now r shortly intend to be working directly with the data apes from NHANES-II. The purposes are 3-fold:

. To promote communication and data exchange.
. To limit unnecessary duplication of effort.
. To track NHANES-related research and publications.

here is certainly no question that we will learn more bout the nutritional status of Americans from study of the HANES-II data than has ever been possible before. Now hat the cleaned-up data tapes are becoming available, I an- icipate that our clinical nutrition research group will be orking virtually non-stop on the data for at least two ears. At FDA, our key interests are specifically focused n three areas: possible changes in our fortification olicies; changes that may have occurred in the nutritional uality of our food supply as consumed; and the prevalence f hypertension, the latter in connection with our new nitiatives to assist the public in lowering sodium consump- ion. As many of you have heard me say before, I anticipate hat we will have the best possible grasp of iron nutriture n the U.S. in another several years as a result of NHANES- I data analysis plus the results of clinical studies con- erning efficacy of iron fortification; the effect of die- ary iron on the pathogenesis of iron-storage disorders; nd the significance of iron deficits in terms of physical erformance and behavioral and cognitive development. We ay well reopen the iron fortification issue again after ll the data are in and have been analyzed and interpreted. addition, NHANES-II will give us the first truly national cture of folate and zinc nutriture in the U.S. which may ll impact on fortification policy and practices.

particularly difficult and perplexing area potentially lated to fortification practices is the nutritional as- cts of osteoporosis, particularly in post-menopausal men. Obviously, the societal and personal costs of hip d other bone fractures in our older population are enor- us. There is certainly plenty of evidence that nutri- onal factors play a major role in the prevention and thogenesis of this disease. What remains murky is how l of the involved nutrients interact and interrelate with ch other. We at FDA, along with efforts by the classic omedical research community, are trying to get a better ndle on the subject. Under contract with the Federation

of American Societies for Experimental Biology (FASEB), w have completed review of half of the puzzle, i.e., the roles of calcium, phosphorus, vitamin D and protein. The report of this effort was submitted to FDA in September 1981 ("Effects of Dietary Factors on Skeletal Integrity in Adults: Calcium, Phosphorus, Vitamin D, and Protein"), an is available through the National Technical Information Service (NTIS #DB 82-131475). A key conclusion is that "There is evidence to support the prophylactic use of calcium supplementation among post-menopausal women, but its therapeutic utility remains controversial." The second half of the review process is under way now addressing magnesium, zinc, fluoride, vitamin A, vitamin K and anothe look at vitamin D. In this regard, a workshop of experts will be meeting next week at FASEB to review these subject under the general subject of the Effects of Certain Trace Minerals and Vitamins on Calcium and Phosphorus Homeostasis. The ultimate role that fortification may play in at least partially ameliorating osteoporosis is certainly not clear at present, but it is reasonable to hypothesize that the potential for a real contribution exists. I hope that the cereal chemists and the cereal-based industry wil join in pursuit of this concept to develop a sound scientific base for future action.

In summary, FDA is an advocate of rational food fortification. Internationally, interest in fortification is increasing, and FDA is playing a modest role in stimulating this interest. U.S. fortification policies and practices may change by the mid-1980's, particularly as influenced by analysis and interpretation of NHANES-II data. Problems of mineral bioavailability when plant-derived proteins are used as major dietary constituents can probably be overcome in large measure by fortification and use of enhancers. And, finally, there are some fascinating possibilities in the future, e.g., the potential value of fortification in ameliorating certain degenerative diseases such as osteo porosis.

I hope this discussion gives you some insight into FDA's thinking on nutrient additions to foods. Thank you very much for your attention.

FOOD FORTIFICATION POLICY AT USDA

Mary C. Jarratt
Assistant Secretary for Food and Consumer Services

U.S. Department of Agriculture
Washington, D.C. 20250
(202) 447-7711

'm pleased to be with you today to share with you some
houghts about food fortification, its benefits and
roblems, and USDA's position on fortification. This con-
erence is a good indication of the level of interest and
oncern about this topic--an interest shared by food produc-
rs and processors as well as nutritionists.

he history of food fortification has by and large been a
uccess story. Food fortification programs were started in
he U.S. as a means of correcting serious nutritional
eficiencies in some segments of the population. Iodine was
dded to salt to prevent goiter; vitamin D to milk to pre-
ent rickets. In 1942, after the discovery of iron,
hiamin, niacin and riboflavin deficiencies in some popula-
ion groups, bread and flour were enriched with these nutri-
nts. After grain enrichment was begun, there was a sharp
ise in the amounts of iron, thiamin, riboflavin and niacin
vailable in the U.S. food supply.

SDA has conducted several surveys to determine the contri-
itions made by fortification to nutrient levels in the
itional food supply. We have always found nutrient manu-
acturers and importers to be very helpful in these surveys.
anufacturers and importers have provided information about
he amounts of vitamins and minerals added to the food
pply. From the data they supply, we know that nutrients
dded in fortification make a significant contribution to
he American diet. Our last survey was conducted in 1971
nd we are getting ready to do a similar study this year.

he decline in the prevalence of nutrient deficiency
iseases in the U.S. in many cases preceded the introduction
fortification, so fortification cannot take all the

credit. Many economic, educational and public health changes occurred simultaneously with changes in the food supply. Fortification is now an established practice to prevent the reappearance of the deficiency diseases.

Some Problems With Fortification

But fortification does present some problems. Some nutrients are toxic when consumed in excess. In particula we are concerned about vitamins A and D and some of the trace elements. Therefore, we must be cautious about indi criminate fortification of foods. We are concerned about the use of highly fortified foods by some people, particu- larly children, may result in toxicity. For example, vita D toxicity is relatively rare in the U.S. Most cases are attributed to abuse of vitamin supplements and not to fortified foods. However, the potential exists for excess vitamin D intake by children when several foods and dietar supplements are each formulated to provide the Recommended Dietary Allowance under conditions of normal use. In view of this, many WIC state agencies limit the use of 100 perce fortified cereals for children under 4 years--the vitamin A and D levels being considered too high for this age group.

Fortification also poses an educational dilemma because som people, particularly children, may not be able to distingui between fortified foods and their unfortified counterparts. Widespread fortification could mislead consumers about the overall nutritional value of various kinds of foods. Some people mistakenly believe that eating fortified foods ensur a completely nutritious diet. Some people also believe tha they need to eat highly fortified foods and that these food provide nutritional benefits they cannot get from conven- tional foods. As the food supply becomes more complex and as more fortified foods are introduced, the task of nutriti education becomes more complex.

USDA's Position On Fortification

USDA accepts grain enrichment as an integral part of the fo supply. Given the nature of our food supply, we don't question whether the addition of nutrients to foods is a legitimate practice. It is. We do question the levels to which grains might be safely fortified and which other food might be appropriate carriers.

In formulating our position on fortification, we have relie heavily on the Food and Nutrition Board's published state- ments and on the Food and Drug Administration's guidelines.

The Food and Nutrition Board has repeatedly stressed that an individual should obtain nutrients from a wide variety of foods. In its "Recommended Dietary Allowances" the Board states:

> "RDA's are intended to be met by a diet of a wide variety of foods rather than by supplementation or by extensive fortification of single foods. RDA's have not been set for all recognized nutrients...Therefore diets should be composed of a variety of foods...

We have shared the concerns of the Food and Drug Administration about the possibility of random or arbitrary fortification practices. If guidelines were not established, the food supply could be overfortified with nutrients that are simple and inexpensive to add to food or underfortified with other nutrients such as trace minerals. Either of these situations could cause public health problems. The fortification policy published by FDA in 1980 has provided much needed guidance in this complex area.

The Department of Agriculture has been criticized in the past for an inconsistent policy on fortification. However, the issue is a complicated one. Nutrients are added to different foods for a variety of reasons and in a variety of ways. There are advantages to the use of fortified foods, but there are also concerns that they may be used inappropriately. We want to be able to retain flexibility in our education, food assistance, and regulatory programs.

There are four principles upon which USDA's position on fortification are based. Fortification can be used when all of the following conditions are met:

1. There is a demonstrated need for the nutrient in the specified population;

2. The use of the product is not likely to create a dietary imbalance;

3. The vehicle to which nutrients are added is an appropriate one;

4. The use of the product will not be confusing or misleading to consumers.

In our nutrition education programs, we believe it is preferable to promote the use of conventional foods. This approach

is based on our knowledge that fortified foods do not provide all the known essential nutrients, and may not provid significant amounts of dietary components such as fiber which make useful contributions to health.

In addition, we are concerned that many fortified foods ar excessively high in sugar, fat and sodium.

In some of our food assistance programs, we specify nutrien levels in foods for populations with demonstrated nutrition needs. In order to meet these levels, fortification is som times permitted. I will now discuss these programs.

The Supplemental Food Program for Women, Infants, and Children (WIC)

This program currently provides supplemental foods and nutrition education to about 2 million low-income pregnant, postpartum, and breastfeeding women, and it provides supplemental foods to infants and children up to their fifth birth day. To meet the dietary needs of these recipients, who are at nutritional risks, the Department has developed WIC food packages. Foods in these packages have high levels of vitamins A and C, calcium, iron and protein.

Here is what is in the food packages: milk fortified with vitamins A and D; infant formula fortified with vitamins and minerals; infant cereal which contains a minimum of 45 milligrams of iron per 100 grams of dry ceral; dry cereal which contains a minimum of 28 milligrams of iron per 100 grams of dry cereal; fruit and vegetable juices that have vitamin C, either naturally or by fortification; and finally, the package contains cheese, eggs, peanut butter, dry beans, and dry peas. No fortification is in these last items.

Why do we provide this group with dry infant and adult cereals that are fortified with iron?

Cereals, which are inexpensive, widely available, and popula are the major source of iron in the WIC food packages. And iron deficiency is a major nutritional problem for WIC participants.

We have set the iron fortification level for WIC adult cereals at 45 percent of the USRDA per one ounce dry serving This was done on the recommendation of a food package task force, on the recommendation and advice of professional nutritionists, and in response to public concern about 45 percent be a minimum requirement. This is also the stated

preference of state and local professionals working in the program. Currently there are about 20 adult dry cereals which meet the iron and other requirements for WIC cereals.

At the moment several USDA agencies are investigating the relationship of various fortification levels and types of iron used in cereals to the amounts of this mineral that are actually absorbed. Results from these studies would be considered when changes are made in the food packages.

Child Nutrition Programs

Foods purchased for the child nutrition and needy family programs can be fortified only if FDA has a standard for the product, as for enriched flour. An exception to this policy is that dehydrated mash potatoes, to which vitamins A and C have been added, are allowed.

Essentially, we do not rely on fortified foods to meet dietary needs in the child nutrition programs. However, there are exceptions, and these are contained in appendix A of the child nutrition regulations. The exceptions are formulated grain-fruit products, cheese alternate products, vegetable protein products, and enriched macaroni products with fortified protein. The Department has developed guidelines for schools which desire to use these products. The schools may use these products at their own discretion. The main reason the Department allows their use is to give local schools greater flexibility in meal preparation, thus allowing them a means to make significant cost savings.

Manufacturers who seek acceptance of such products must furnish Food and Nutrition Service a chemical analysis, protein efficiency ratio analysis, and other pertinent data as may be requested.

Now let's take a look at each of the products.

-Formulated Grain-fruit Products

These are either sweet rolls, doughnuts, or fruit fill products that schools can use to meet part of the school breakfast requirements. When served with a half-pint of milk, they meet fruit or vegetable and bread requirements for breakfast. The Department allows the use of this product to encourage schools with no food service facilities to serve breakfast, and to permit schools to serve a convenient, less costly breakfast.

--Cheese Alternate Product

Needless to say, with all the surplus cheese we now have, there is no current demand for cheese alternate products. However, this product is permitted in the regulations. Cheese alternate products may be served in combination wit natural or processed cheese to meet part or all the meat o meat alternate requirements in the national school lunch program. The quantity of the cheese alternate product in the combination may not exceed the weight of the natural o processed cheese.

--Vegetable Protein Products

These products may be used in combination with meat, poultry, or fish to meet part of the meat requirement of schoo lunches. The proportion of vegetable protein product to uncooked meat, in the combined dish, may not exceed a ratio of 30 parts vegetable protein product to 70 parts meat. Vegetable protein products are served in combination with ground or diced meat in meat patties, meat loaves, meat sauces, meat stews, or in similar foods made with poultry or fish.

--Enriched Macaroni Products with Fortified Protein

These products may be used to meet up to one half of the meat or meat alternate requirements when served in combination with cooked meat, poultry or cheese; or they may be used to meet all or part of the bread requirement.

Meat and Poultry-FSIS's Regulatory Stance

The policy of not allowing direct fortification of meat and poultry products has been in effect in USDA for many years. It is based on the philosophy that the additions of nutrients should be reserved for those instances in which there is a demonstrated need; and meat and poultry are highly nutritious foods which do not need fortification. We do not consider it wise to fortify products just for the sake of fortification. However, the Food Safety and Inspection Service does allow fortified ingredients such as enriched flour to be used in meat and poultry products if those ingredients are fortified according to a standard. The Food Safety and Inspection Service also allows fortification of meat or poultry products to fulfill a standard of identity.

Summary

In closing, I want to summarize our position. Fortification can be used when all of the following conditions are met:

1. There is a demonstrated need for the nutrient in the specified population;

2. The use of the product is not likely to create a dietary imbalance;

3. The vehicle to which nutrients are added is an appropriate one;

4. The use of the product will not be confusing or misleading to consumers.

I would like to make one more point regarding the question of fortification. Under the guidelines I've just stated, the Department certainly does recognize the important role fortification can play in the foods we eat. However, we believe it is generally preferable to promote the use of conventional foods.

Thank you for your invitation to come here. I look forward to reading your policy statement.

CLIMATE FOR DIETARY IMPROVEMENT

William J. Hoover

American Institute of Baking
1213 Bakers Way
Manhattan, Kansas 66502

The world food problem of great concern in the decade of the 60's and early years of the 70's has been less in the news, but just as real in the last few years. Good weather has provided good grain harvests which resulted in a holding action in the race against hunger. Nevertheless, it still appears that the world population is increasing at a faster rate than is the ability to produce food. The current world population is around four billion people and growing toward six billion in the next 20 years -- adding over one million people per week.

Crucial aspects of this dilemma are that the population and food problems center in already diet deficient countries where food production is low and population growths are high. Successful birth control programs can not correct the course toward hunger in the next 20 years. Birthrates have not increased for the last 40 years, but death rates/thousand have decreased from 35 in the 1940's to under 10 presently.

Thus, the focus must be on the food side of the equation. It is up to agriculture and agriculturally oriented business to solve the approaching world food problem. A global nutritional goal should be to provide nourishment of humanity for maximum fulfillment of tenure and activity.[1/]

There is a relative concensus of the broad dimensions of hunger and of the trends. More specific assessment is difficult because of inadequate data and biases in both data and interpretations, which swing widely from pessimistic to optimistic opinions. The collective assessment of 130 governments at the time of the Rome World Food Conference in 1974 was that 460 million people or one-eighth of humanity was malnourished. A more recent

publication of the world bank reports that half of the people in the developing world are malnourished -- over o billion individuals do not consume enough food to meet th daily caloric requirements.[27] The report further states that 895 million have daily caloric deficits over 250 calories, and that caloric deficiencies are frequently acc panied by protein deficits and vitamin and mineral deficiencies are even more widespread.

The world bank report also highlights the concentration of malnutrition with 78% of the malnourished being in Asia, 4% in the Middle East, 8% in Latin America and 10% in Africa. In Asia, 63% of the population is malnourished, in Africa 61%, in Latin America 23% and in the Middle East 13%.

Whatever the correct numbers are, it is a fact that every year there are additional millions of malnourished people in the poorer countries, who have a rising dependency upon grain imports.

A summary of many assessments would indicate a current 10-15% calorie deficiency in available food energy. For protein, there is a critical lack of both quantity and nutritive quality particularly for children and lactating women. Several sources indicate a 10-15% deficit of the B vitamins and as much as 50% deficit for Vitamin A and calcium.

The fundamental role of grain based foods are profoundly evident in the fact that 95% of the world's population consume most of their calories from grains. Fifty percent of the world's protein supply is from grain with over 70% of protein in developing countries being from grain. More specifically, rice provides 60% of the total calories for 53% of all people. Wheat is the staple for 36% of people, corn is the staple for 4% of people, and sorghum and millet provide the basic diet for about 1.5% of the world population. To supply these foods: 31% of cropland is planted to wheat; 19% in rice; 16% in corn and 15% in sorghum and millet.

A basic question for debate dating from the time of Malthus who felt that population would be naturally limited by resources, has been just how many people the earth can support. Predictions are easy to find and range from those who feel the earth's resources can not sustain our present population, to those who predict 25 billion people can be accomodated. It is not particularly rewarding to worry

out the ultimate level. Rather, attention should be irected at how we can best manage the resources we do have.

ie critical components of providing adequate nourishment or all people are resources, technology, and policies about ie production and use of food. Resource and technological equirements are assessed widely as limiting or ample. I elieve that the knowhow and basic resources are available o feed our current population. The political will or nowhow to set government policies to achieve this is lack- ng.

o date, global nutritional adequacy or country specific utritional adequacy has not been established as the high riority goal in any country. Rich, powerful, food surplus ountries are prime determiners of global nutritional dequacy both as pace setters in their own policies, and in haring abroad food, technology and investment assistance. ie United States consistently has a policy aimed at dequate food to meet effective demand under free play of arket forces. The aim is to reduce handouts and increase ales. Nevertheless, the U.S. generosity seeks to aid and et increasing food production in the poorest countries here most needed, and to provide a limited amount of food d. But, because of the importance of grain markets, the S. will continue to make effective demand rather than utritional adequacy the heart of U.S. food policy.

od production is an individual country responsibility and lf-reliance should be the goal. Unfortunately, nutrition not a specific objective of food production policies d food production policies are rarely a first priority policy makers in developing countries. The constraints increasing food production must be dealt with through vernmental policies.

rmidable constraints are poverty, the energy crisis, isting marketing systems and lack of a support infra- ucture for the producer.

verty holds down production as farmers can not afford the puts -- seed, fertilizer and chemicals, and inflation kes it worse. The energy crisis has resulted in high ices for fuel and fertilizer, and stripped many countries precious foreign exchange curriencies. Poor post rvest marketing facilities for handling, transporting, oring, and processing compound the problem with resulting stage of too much of the products which have been

produced. Governmental failure to provide agricultural research and extension services, farm credit and a stru tured marketing system also leads to production ineffic or fails to provide incentives to the producer to impro his output.

Solution to the world food situation will require more just food production increases. The complex web of nutrition is interlaced with a multitude of interactions There is no panacea for nutritional improvement. Generi corrective thrusts include slowing population growth, increasing food production, changing food consumption patterns or habits, improving food systems through food cereal technology, and reducing waste before and after harvest.

Austin[3/] in his latest book summarizes the types of nutr tional programs or interventions which are being used in developing countries. The main types of programs are:

1. Agricultural Production. Programs aimed at increasi production can generate positive nutritional impacts through income generation for the farmer and product avai ability for the consumer. Policies for increasing agri- cultural production do not take nutritional impact explic ly into account.

2. Price Subsidies. Increasing access for the poor to f can be accomplished through many forms of subsidies: foo stamps, ration shops, price and margin controls. Unfor- tunately, there are no governments who can continually su sidize food costs in any massive way without going broke, and there are a number of governments approaching bankrup now for this very reason.

3. Supplementary Feeding. These programs, largely aimed at children, supplement their regular food most generally through direct feeding programs in schools and other institutional situations. Take home programs through mother child health centers or food for work programs are now more prevalent than direct feeding programs, but have the feature of diffusing the food to the whole family rather than a particular target group or individual.

4. Nutrition Education. The aim is to influence food selection to maximize the nutritional intake from the food choices available. This is usually done in consort with a supplementary feeding program.

Formulated Foods. A family of nutrient dense products th higher protein quality have been developed for use in eding programs. These foods are particularly valuable weaning foods and in supplementary feeding programs. fortunately, sustained regular market success rarely has en attained for these foods to date.

Fortification. This involves adding selected nutrients normally consumed foods to remedy specific nutrient ficiencies. Iodization of salt is by far the most widely acticed form of fortification. Other interventions assified by Austin as fortification include plant breeding r nutrient improvement, or mass doses of specific nutri- ts provided orally or by injection.

Integrated Programs. Many efforts involve combinations the above with related programs of primary health care, ter and sanitation and family planning. Such integration rmits more economical simultaneous approaches to a mixture social problems.

stin also provided an interesting table which gave summary timates of intervention costs:

ricultural Production	-- Depends on nature of project.
nsumer Price Subsidies	- 5-25% of total government expenditures.
pplementary Feeding	-- $10-25 per recipient per year.
trition Education	-- $.05-3 per recipient.
rmulated Foods	-- $.001-.003 per gm protein, $.007-.014 per 100 calories.
rtification	-- $.002-.11 per recipient per year for micronutrients $2.50 per recipient per year for lysine
egrated Programs	-- $15-50 per beneficiary per year; 5-20% cost savings over non-integrated.

recent years, there has been a woeful lack of focus on rients. The protein thrust of nutrition programs in the ade of the 60's and the first half of the 1970's, gave in a great collapse to the crusade that the real blem is just poverty. If more food and thus more lories are achieved, then the nutrient needs will take e of themselves became the popular thrust. This still evalent thesis is that given more money, people will eat ter (both quantity and nutritional quality). This ular philosophy has caused a general decrease in interest

in nutrient enrichment and fortification, as an economi and practical way of improving food efficiency.

Axford and Williams[4/] recently summarized the status of flour enrichment around the world. Only Canada, Guyana and Denmark require mandatory enrichment of flour. Six countries: USA; Australia; Kenya; Zambia; Portugal; an Spain permit enrichment, with standards. In Japan and Sweden enrichment is permitted, without standards. Whi in twelve countries: New Zealand; Namibia; South Afric Saudi Arabia; Austria; Belgium; France; Italy; Netherla Norway; Switzerland; and West Germany allow enrichment have no legal provisions.

The question must be addressed as to why so little flour enrichment is done over 40 years after its introduction North America? The technology is simple, the cost reaso able, the control and logistics easy, and the results demonstrable. Global compulsory fortification of wheat other cereal flours could virtually insure adequacy of protein, vitamins and mineral intakes for those who obta their flours from centrally processed grain.

We, as cereal chemists, must shoulder the responsibility for leading an extension program to herald the value of enrichment and fortification and help in implementing material or singularly commercial endeavors around the world. We must encourage the study of the economic and technological feasibility of methods to improve nutrition for vulnerable groups through national programs includin enrichment and fortification. We must rekindle interest in this approach in our own governments programs and offe technical assistance as individuals and through the Counc for Enrichment and Fortification of the AACC.

Sound nutrition is essential for maximizing the physical and mental capabilities of people. This is <u>not</u> fully understood. Vast ignorance prevails -- the very large benefits of good nutrition are not appreciated, and the relatively low costs of nutrient fortification are not known. Providing this basic knowledge and understanding should be our first objective in an intensified program supported by government, industry, and professional cerea chemists and nutritionists.

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THE ROLE OF GRAIN BASED FOOD IN SUPPLYING NUTRIENTS

Paul A. Lachance, Ph.D.
Professor, Food Science and Nutrition

Rutgers University
New Brunswick, NJ 08903

INTRODUCTION

In 1974, the Food and Nutrition Board of the National Academy of Sciences published a document entitled "Proposed Fortification Policy for Cereal-Grain Products" (Food and Nutrition Board, 1974). It was recommended that all products based on the major U.S. cereal grains, i.e., wheat, corn and rice, be fortified with certain nutrients where technically feasible. The proposal stimulated a series of systematic studies, particularly of wheat (Davis et al., 1980) (Davis et al., 1981) and wheat flour compositon (Kulp et al., 1980) (Keagy et al., 1980) (Lorenz et al., 1980) (Ranum et al., 1980). Other studies have considered the interaction of the addition of micronutrients upon the quality of wheat flour (Ranum et al., 1981); of bread (Emodi et al., 1980); and, cereal-grain products (Rubin et al., 1977). Fortification technology consideration (Ranum, 1980) (Parrish et al., 1980) have also been published.

Role of Cereal Grain and Products

The role of cereal grain products in the U.S. diet has been the topic of a recent review (Lachance, 1980); and several technical books have been edited on various cereal grains and products (Inglett, 1970; 1974; Luh, 1980; Houston, 1972; Pomeranz, 1982).

To briefly synopsize all of this information is not possible, but one can highlight certain facts that unequivocably demonstrate the broad and unique role of cereal grain food in the dietary.

On a worldwide basis, cereal-grain products consti the most significant portion of the daily intake of cal ies and nutrients. In the USA, 24 percent of the avera daily intake of calories and associated nutrients are attributable to cereal grain products per se. Another substantial percentage of cereal grain makes possible t quality of two other food groups; dairy products and me poultry and egg products. This role of cereal grains i three of the four food groups is invariably overlooked.

Cereal grain products are economical (Rehkugler, 19 and are within the purchasing power of the majority of t population. Cereal grain products are broadly consumed, a high frequency, by all age and income groups of the U. population (U.S.DHEW, 1979).

Cereal grains, uncontaminated by mycotoxins, have exceedingly low health risks attributable to endogenous naturally occurring toxicants. In other words, properly grown and handled cereal grains have a very high level o safety.

Cereal grains are associated with positive health factors: low fat, high percentage of polyunsaturated fat and high concentration of complex carbohydrate, including nondigestible fiber. The key nutritive characteristics, including the essential amino acid profile, of the three significant cereal grains in the U.S. diet - wheat, corn and rice - are provided in Tables I and II. The nutritiv value contribution of cereal grains products is reflected in the fact that Food Guides universally have advocated t consumption of a minimum of four servings of cereal grain products per day. (Ahlström and Räsänen, 1973)

TABLE I: NUTRITIVE VALUE OF THREE CEREALS

	Bolted Corn Meal	Wheat Flour	White R
Moisture (%)	12.0	12.0	12.0
Kcal/100 gm	362	364	363
Protein (%)	9.0	10.5	6.7
Fat (%)	3.4	0.5	0.4
Carbohydrate (%)	74.5	76.1	80.4
Ash (%)	1.1	0.43	0.3
Ca (Mg/100 gm)	17	16	24
Phosphorus	223	87	94
Iron	1.8	0.8	0.8
Thiamin	0.30	0.06	0.0
Riboflavin	0.08	0.05	0.0
Niacin	1.9	0.9	1.6
Vitamin A (IU)	480	0	0

.BLE II: ESSENTIAL AMINO ACID CONTENT OF THE CEREAL PROTEINS

	Percentage		
	Wheat	Corn	White Rice
rginine	14.06	9.36	8.4
istidine	7.89	0.75	2.6
soleucine	0	0.8	4.5
eucine	33.91	31.22	8.4
ysine	5.88	6.71	3.5
ethionine	4.85	2.35	2.5
henylalanine	8.40	9.34	4.5
hreonine	2.0	2.90	3.9
ryptophane	8.14	2.07	1.2
aline	3.82	1.88	6.5

Role of Wheat and Products:

The per capita U.S. consumption of wheat cereal products is 15 times that of corn or rice. The seeds of wheat are said to be the seeds of civilization, and archeologists have found evidence of wheat as a food at Jarmo (6700 BC). It is little wonder that the word cereal comes from Ceres, the Roman goddess of agriculture and the harvest. The significant nutrients of whole wheat and wheat flour are listed in Table III. The nutrients of wheat are invariably consumed as bread and related baked goods. Around the world, bread is the principle food and provides more nutrients than any other single food source. (Pomeranz and Shellenberger, 1971). The average quantity of flour equivalent whole grain or enriched products used by U.S. households in 1977 was 2.05 pounds per week. (Hama, 1980)

ABLE III: WHEAT, WHEAT FLOUR AND FORTIFIED FLOUR NUTRIENT LEVEL PER 100 GM

TRIENT	UNIT	WHOLE WHEAT	WHEAT FLOUR*	"FNB FLOUR**
OTEIN	G	13.8	10.9	X***
IAMIN	MG	0.46	0.2	0.64
BOFLAVIN	MG	0.13	0.05	0.40
CIN	MG	5.5	1.35	5.3
LIC ACID	MG	0.04	0.02	0.07
TAMIN B_6	MG	0.46	0.05	0.44
NTOTHENIC ACID	MG	1.0	0.32	X
OTIN	MG	0.01	0.002	X
TAMIN A	I.U.	0	0	946
TAMIN E	MG	3.28	1.50	X
TAMIN K	MG	0.017	0.004	X
LCIUM	MG	35	15.8	198
RON	MG	3.0	0.9	4.4
AGNESIUM	MG	140	26	44
OPPER	MG	0.5	0.1	X
INC	MG	3.0	0.8	2.2

* 74% EXTRACTION
** PROPOSED RESOTRATION/ENRICHMENT LEVEL
*** RESTORATION ALSO FEASIBLE

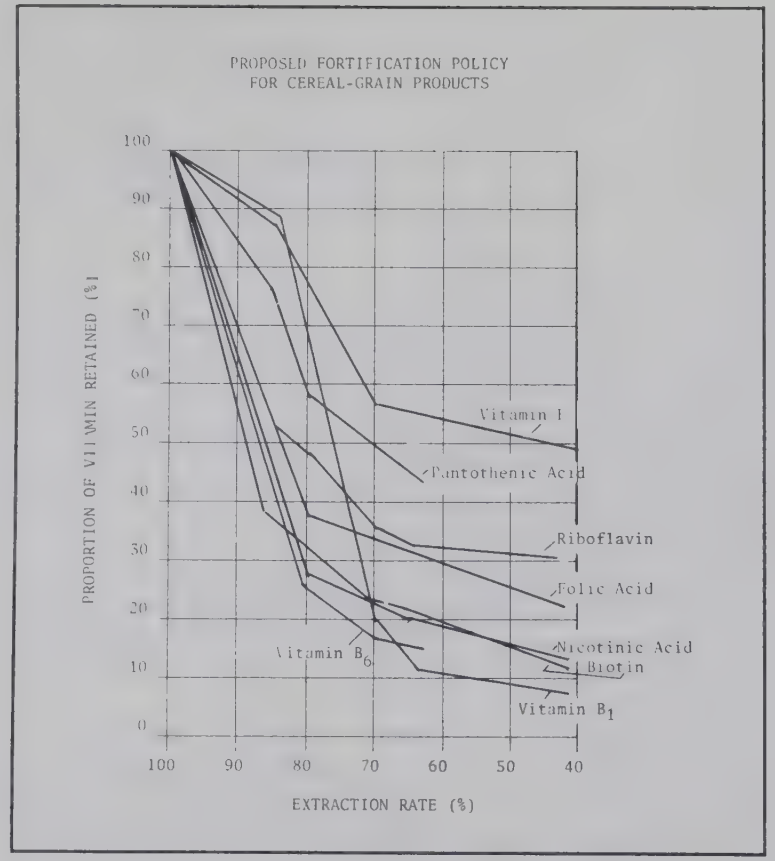


Fig. I RELATION BETWEEN RATE AND PROPORTION of total vitamins of the grain retained in flour (reproduced with permission from p.90 of Wheat in Human Nutrition; FOOD & NUTRITION BOARD 1974)

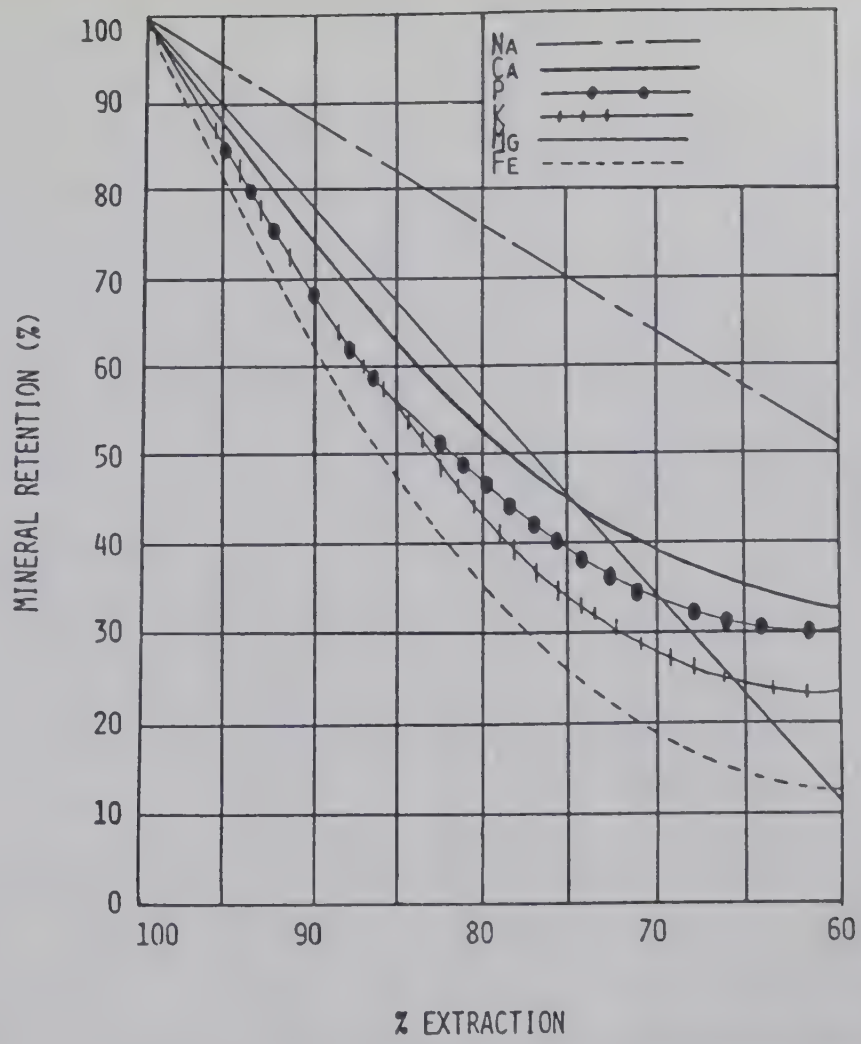


Fig. II CHANGES IN MINERAL CONTENT OF

Discussion:

There is no question that the milling of grain into flour provides enhanced functional and sensory attributes, but also diminishes nutritive value attributes, (Figures I and II). Retention of the nutrient dense aleurone layer with the bran accounts for a substantial partitioning of key nutrients between the high fiber "feed" stream and the low fiber "flour" stream. The difference in nutritive value between whole wheat and wheat flour (Table III) is illustrative. What conventional nutrition wisdom overlooks is that the feed stream nutrients are realized as value-added food products in terms of dairy products and meat, poultry and egg products.

Common sense economics would indicate that a technological practice such as nutrification (restoration, public health enrichment and fortification) is cost effective. It is recognized and practiced in the least cost formulation of feeds to obtain cost effective dairy products and meat, poultry and egg products, but paranoia seems to take precedence when the practice applies to cereal grain food products for human consumption.

Common sense nutrition would indicate that since nutrients are invisible and nutrition knowledge is subject to social handicaps such as functional illiteracy, the assurance of the intake of the RDA of nutrients by a population can be realized by the combination of nutrification technology and education which emphasizes the consumption of the proper daily proportions of servings of plant and animal foods (Lachance, 1981 b) (Figure III).

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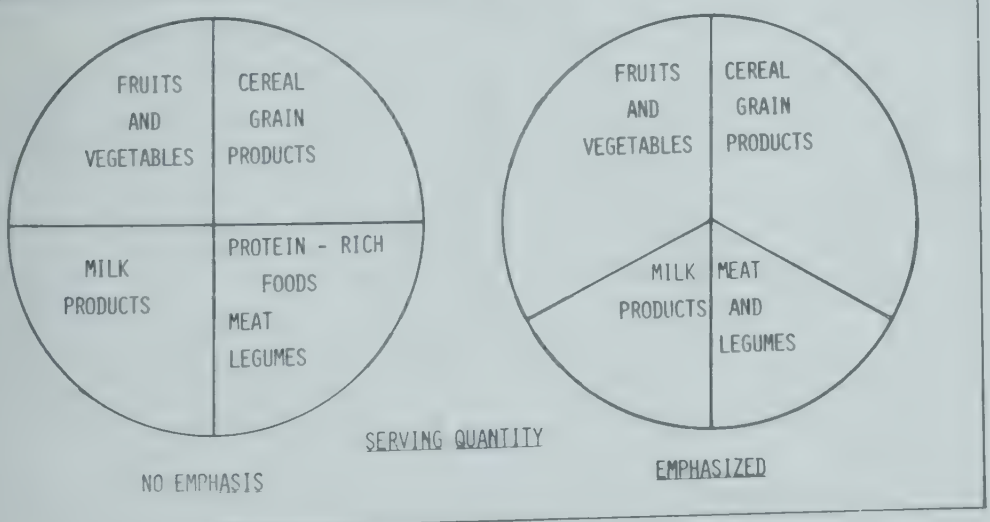


Fig. III Alternative representations of the Four Food Groups

Common sense food product development and technology would indicate that functional and sensory characteristic notwithstanding, a responsibility exists to assure, at a minimum, that the nutritive value "image" of the product present for the consumer to fully realize the benefits of foods (Lachance, 1972).

The per capita weekly flour equivalent consumption in the U.S. is given in Table IV. The contribution of nutrients and health factors to the dietary is substantial. The consumer has access to food labels in USRDA units. In terms of USRDA units the contribution of enriched bread and nutrified bread is self-evident (Figure IV, V). Further, if the consumer were to shift from the current average flour equivalent intake of 2.00 LB/WK to the Basic Four recommended 2.66 LB/WK, the advantage of the additional nutrients would also be realized (Table V).

TABLE IV: FLOUR EQUIVALENT CONSUMPTION BY ANNUAL INCOME

	LESS THAN $6,000	$6,000 TO $10,000	$10,001 TO $17,000	$17,001 TO $26,000	MORE THAN $26,000
ENRICHED OR WHOLE GRAIN (POUNDS/WEEK)	2.26	2.12	2.00	1.90	1.96

TABLE V: PER CAPITA FLOUR EQUIVALENT *USRDA CONTRIBUTION OF NUTRIFIED CEREAL GRAIN

NUTRIENT/BASED ON:	2.00 LB/WK	2.66 LB/WK
(CURRENT)		
THIAMINE	50	70
RIBOFLAVIN	30	40
NIACIN	30	40
IRON (20 MG/LB)	30	40
(PROPOSED)		
VITAMIN A	25	30
VITAMIN B_6	25	35
FOLIC ACID	20	25
CALCIUM	25	30
MAGNESIUM	10	15
ZINC	15	25

*FLOUR EQUIVALENT: WEIGHT OF FLOUR, CEREALS, MEALS, PASTAS, PLUS DRY WEIGHT OF FLOUR, CEREALS, MEALS AND PASTAS IN PREPARED AND BAKERY PRODUCTS.

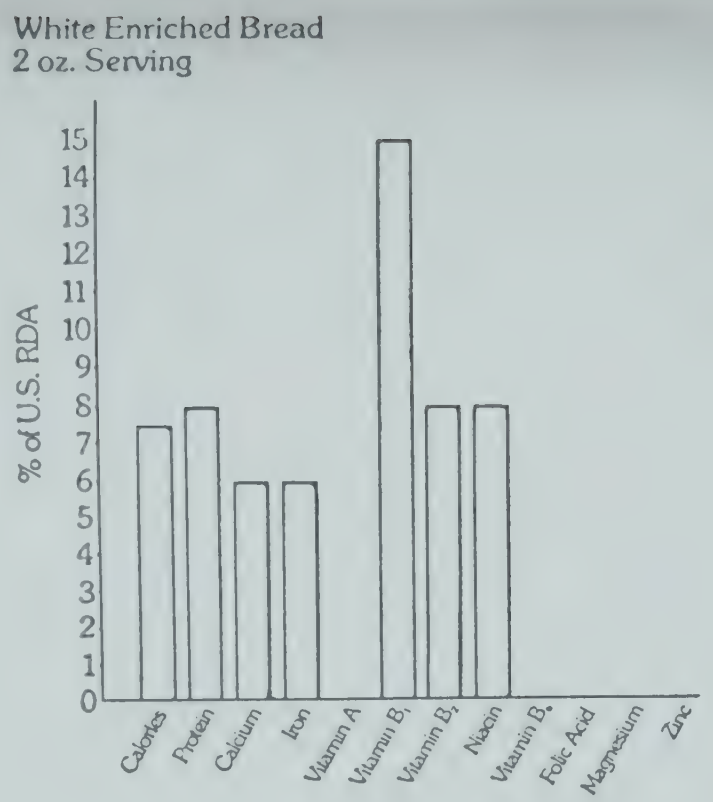


Fig. IV Usual USRDA Profile for Enriched Bread.

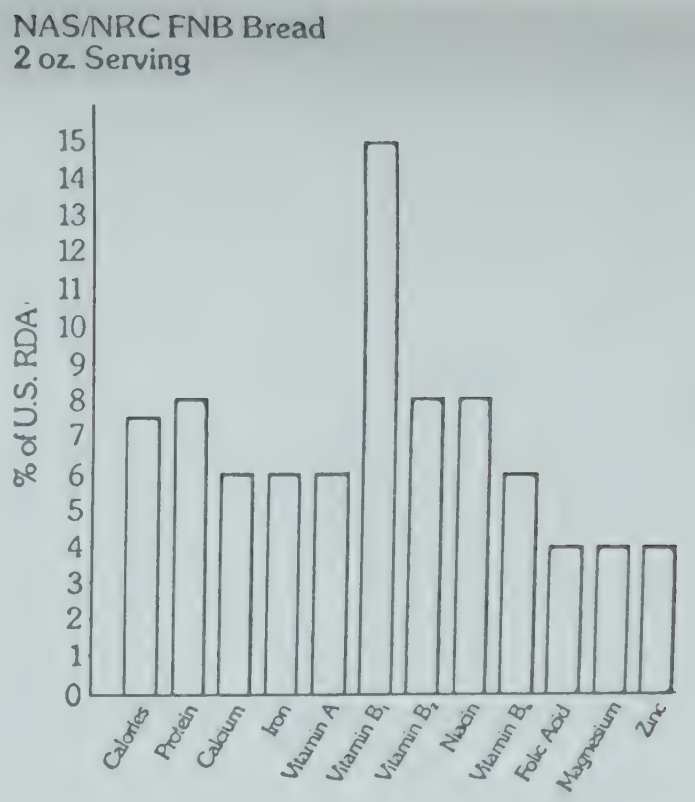


Fig. V USRDA Profile for 1974 NAS/NRC Fortified Bread.

Public policy common sense would reveal that the ri of malnutrition are greater in lower income or fixed inc populations. In times of "safety net" economics this ri becomes greater and the population as a whole shifts to greater use of flour equivalent foods, therefore, public policy should encourage rather than thwart the nutrificat of cereal grain products by the private sector. To break the stalemate, executive branch should make possible the immediate adoption of the proposed NAS/NRC fortification policy for cereal-grain products by executive order. Policymakers in the U.S. must simply cease and desist con fusing food policy and nutrition policy as if nutrition policy were another "thing" that one can be partisan abou It is a question of ethical responsibility which superced politics.

Conclusion:

The role of grain based food in supplying nutrients i most significant because of the array of nutrients involve the range of foods having a cereal-grain component, and th long tradition of cereal-grain safety. Considering the diminishing intake of calories now practiced in the United States; poor consumer awareness of the nutritive value of grain based foods; the need to enhance the nutrient density of low cost foods for calories; and the positive role of cereal-grain products in meeting dietary goals and related guidelines, it should be evident that the implementation of the FNB proposal is long overdue.

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THE NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY DATA AND FOOD FORTIFICATION POLICY

Robert S. Murphy

National Center for Health Statistics
Department of Health and Human Services
3700 East West Highway
Hyattsville, Maryland 20782

BACKGROUND

ıe National Health and Nutrition Examination Survey
HANES) programs conducted by the National Center for
ealth Statistics (NCHS) are unique sources of national data
ıat have been labelled by the Department of Health and
ıman Services in recent congressional testimony as the
:ornerstone" of a proposed National Nutrition Monitoring
stem. [1] It is an important source of data for aspects of
)od fortification policy.

IANES is an expansion of the Health Examination Survey
gun 20 years ago to collect data by direct standardized
:aminations of a sample of the population. Direct
:aminations, coupled with clinical tests and measurements,
e the only source of diagnostic data regarding
recognized and untreated diseases and are, by far, the
st sources for standardized clinical, physical, and
ysiological data on the general U.S. population. The
rst three programs of the Health Examination Survey
:used on different aspects of sickness and health:

1960-62: Adults (18-79 years of age). Information was collected on fairly common chronic diseases, such as arthritis, diabetes, and cardiovascular disease, and various physical and physiological measurements.

1963-65: Children (6-11 years of age). Information was obtained relating to physical, mental, and behavioral growth and development.

1966-70: Youth (12-17 years of age). Information was gathered on growth and development in the teenage years,



Mobile Examination Center



HANES II sample areas

with special emphasis on factors relating to adolescent health, health attitudes, and behavior.

ich survey obtained data on height and weight, other body asurements, dental health, and vision and hearing levels.

1971, responsibility for monitoring and nutritional atus of the population was added and the Health amination Survey became the National Health and Nutrition amination Survey (NHANES). NHANES I, conducted from 1971 1975, was designed to assess overall health status with rticular emphasis on dental health, skin problems, eye nditions, and the nutritional status of the population 74 years of age. For adults 25-74 years of age, detailed mponents for determining the prevalence of chronic lung sease, disabling arthritis of the hip, knee, or lower ine, and cardiovascular disease were included. In dition, information on health care needs and general well-ing were obtained.

r NHANES II, examinations began in February 1976 and ended February 1980. During this period, the mobile amination centers traveled to 64 locations across the untry (MAP) and examined some 21,000 people from 6 months 74 years of age. The areas and subjects for the survey re chosen by sophisticated sampling techniques, in operation with the U.S. Bureau of the Census, to provide a presentative sample of the civilian noninstitutionalized pulation.

ANES II will provide the first look at change in the alth and nutritional status of the population over time sed on:

- A general medical examination and screening by a physician, including a complete medical history.
- Body measurements, including height, weight, and skinfolds, made by trained technicians.
- A dietary interview, including food consumption in the 24 hours prior to examination, conducted by experienced nutritionists.
- Numerous laboratory tests on blood, serum, and urine specimens for nutrients, certain pesticides, lead, carboxyhemoglobin, bile acids and other assessments.

Additional tests and procedures were also included that provide data on diabetes, kidney disease, heart disease hypertension, certain allergies, disc degeneration, pulmonary function, hearing and speech problems, and nutritional problems.

The programs have provided health professionals with estimates of the total prevalence of selected illness, impairments and other indicators of health and nutrition status and the distribution of many conditions or characteristics in the target population by sex, age, in levels, race and region. For the medical community to k what is uncommon, it must know what is common. Repeated NHANES studies can provide data to monitor changes in th prevalence levels and distributions over time. When analyzed for associations, the data collected can often a be used to identify special groups and/or conditions whic should be further studied for better understanding or treatment.

Figures 1-3 demonstrate several nutrition-related issues that NHANES I addressed. Although nutritionists and publ policymakers were concerned with the low caloric intakes reported in national surveys, overweight among adults 20- years affected a significant proportion of our population (Figure 1). [2,3] A higher proportion of women were overweight than men. Hypertension generally increased by each successively older age group (Figure 2); a higher proportion of black persons than white persons had hypertension for most age groups. [4,5] The changes in seru cholesterol levels for men and women estimated from the 1960-1962 Health Examination Survey and NHANES I are of importance because of the current interest in factors related to reduced cardiovascular mortality in the 1970's. Serum cholesterol levels for men appeared consistently lower, but the differences were not statistically significant (Figure 3). [6] For women the levels appeared lower across all age groups but were statistically differe only in the oldest two age groups. NHANES II results will add considerably to analysis of whether serum cholesterol levels are dropping in our population.

The methodologies employed in NHANES I and II have various strengths and weaknesses and present logistical and conceptual challenges that must be dealt with in successfully collecting, analyzing and interpreting the data. Detailed descriptions of all the health examination

Figure 1

Overweight

Men and women 20 percent or more above desirable weight

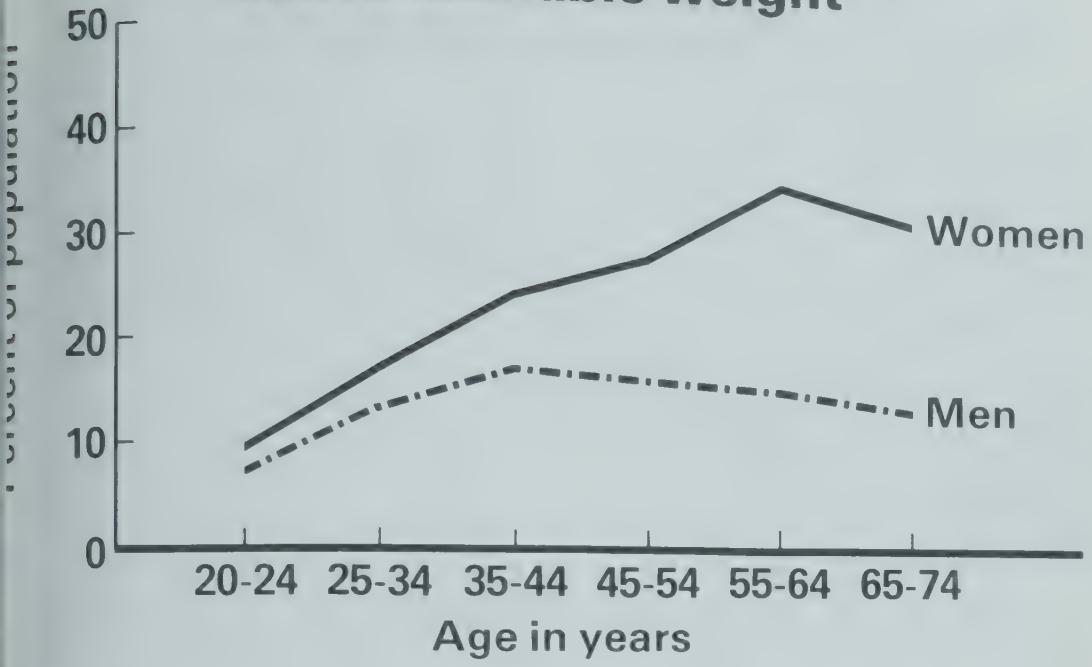
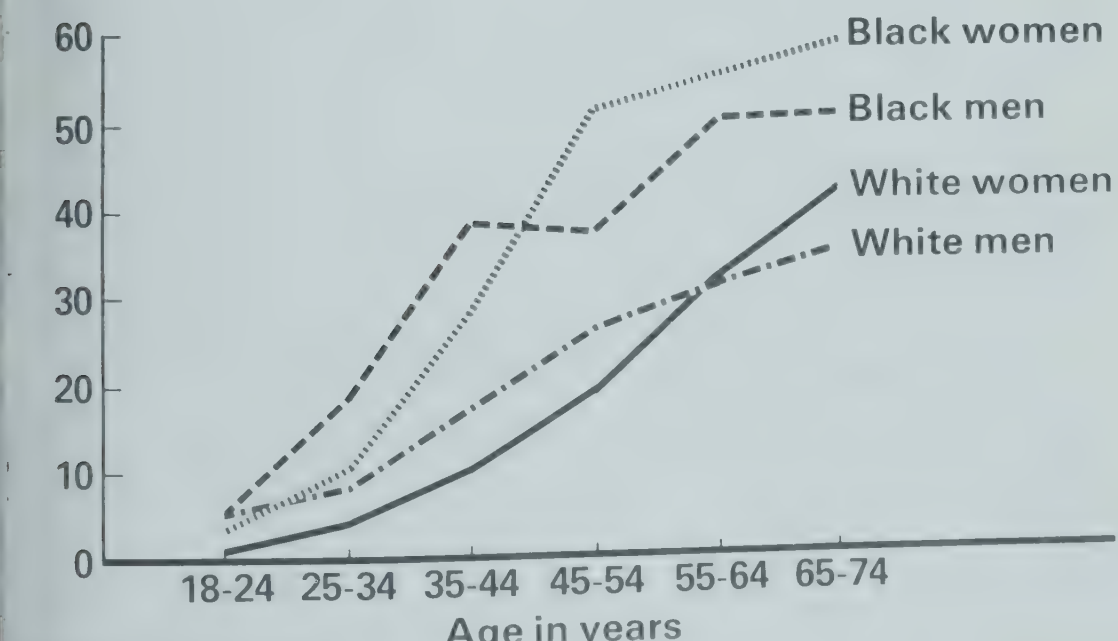


Figure 2

Hypertension*

Prevalence among men and women

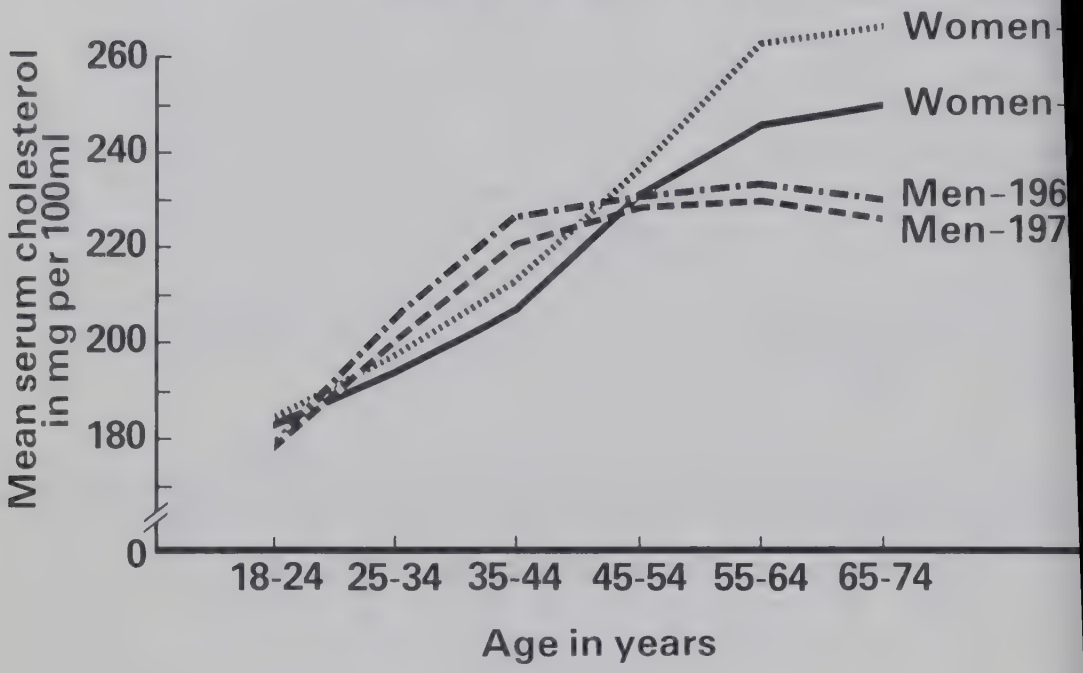


*Not controlled by diet or medication

Figure 3

Cholesterol

Comparative serum cholesterol levels for men and women between 1960's and 1970's



surveys are available in the Vital and Health Statistics series publications. [7-13]

Some strengths of the NHANES programs are significant:

- The sample is representative of the target population by age, race, sex, income and region. The sample is a geographically based probability sample of housing units and persons within these units.

- Scientifically acceptable measures are employed in the data collection process; when possible, examination state-of-the-art or methods of choice are used in developing assessments of an illness or condition.

- The data collection process is carefully planned with respect to content and standardization of procedures. The examinations are conducted in mobile examination centers by a few specially trained staffs comprised of interviewers, doctors, nurses, laboratory and health technicians, and administrative personnel. This aids in providing intensive training, standardization of equipment and environment. For each laboratory test performed off-site a single laboratory is selected to process the materials. A similar process holds for EKG and x-ray readings.

- A rigorous quality and process control program is employed throughout the study enhancing ones ability to evaluate and interpret the results.

- The data collection procedure and techniques are documented in sufficient detail that subsequent programs or other investigators may use them to produce comparable data or against which to compare their results.

- The results are documented and released in a variety of forms: microdata tapes, Vital and Health Statistics reports, journal articles and presentations at professional meetings. For those using the microdata tapes, a limited amount of technical assistance is available through NCHS as resources permit.

Some weaknesses or limitations of the methodologies are also important to recognize:

- Cross-sectional periodic national probability surv cannot provide representative local data in suffic detail to be usable nor can they address rare conditions (less than 1 or 2 percent) with accepta levels of precision.

- Cross-sectional surveys cannot provide causal relationship analyses. Research studies define wha NHANES should include and how the data are to be interpreted.

- Surveys have important logistical and pragmatic constraints that must be carefully weighted in defining the content of a study. The examination procedures and questionnaire materials must not be painful, be embarrassing or be associated with a significant health risk. The examination period should not exceed 3 hours nor require return visits the medical center for very many people. The equipment involved in examination procedures must be reasonably sturdy, relatively inexpensive and capabl of being used by personnel whose formal training is rather limited.

- The current level of biomedical knowledge and techniques available for use in population surveys ma not provide measures that are sufficiently sensitive or specific. Lower than desirable positive or negative predictive values for statistics generated from such studies are distinct possibilities.

- The length of data collection and potential effects o seasonality lead to logistical problems and concerns in data analysis.

- The analyses of data must carefully consider the complex survey design [14] and the potential bias due t nonresponse which is significant in most population studies employing examinations. The examination response rate in NHANES II was 73 percent; medical history results are available for about 90 percent of sample persons. It is vital to have adequate statistical advice in analyzing NHANES data and assessing potential bias due to nonresponse and measuring techniques.

Relevance of NHANES Data to Food Fortification Policy

The NHANES physical measures, physical examination, biochemical assessments and medical history data provide unique national data of immediate relevance to food fortification policy concerns with respect to iron, folic acid, zinc, Vitamin A and Vitamin C. The results for all biochemistries will be presented in several forms:

- o distributions by age, race and sex groups
- o prevalence of low or high values for each biochemistry
- o interrelationships of biochemical assessments
- o comparisons of results with other studies including NHANES I
- o interrelationships of biochemistry results with other available data

The data from NHANES II, for example, permit the characterization of anemia by blood measures of hemoglobin, transferrin saturation, protoporphyrin, ferritin, red cell and serum folate assessments.

For each sample person, a dietitian recorded the quantity of every item of food or drink consumed during the previous day. The data yield foods consumed, grams of food consumed, calories, cholesterol, fat, unsaturated fat, protein, carbohydrates, and specific vitamins and minerals consumed during the recall period. In addition, a food frequency interview ascertained the usual pattern of food consumption, recording whether or not it included any foods in various food groupings including milk, meat, fish, eggs, fats and oils, legumes and nuts, cereals, fruits, vegetables, and alcoholic beverages.

The dietary information can be presented by age, race, sex and other socioeconomic variables for the following:

- o foods consumed
- o amount of food consumed
- o nutrient value of foods consumed
- o nutrient density of "usual" dietary intakes

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- o comparison of reported intakes to a variety of standards

These data together with the medical examination assessme are useful in identifying population groups at high risk nutritional deficiencies and appropriate vehicles of fortification to these groups; models built to assess lev of fortificatin required may also use these data. The da may also suggest further fortification is not necessary o even desirable according to biochemical indicators of nutrient status.

Three recent publications (in preparation) from NHANES I show:

Anemia [15]

- o Low hemoglobin was most common in young children, pregnant women (not shown), elderly men, and the bla population. (Table 1)

- o Low transferrin saturation, indicating that iron status is less than optimal but has not necessarily deteriorated to the point of causing anemia, was the most prevalent condition, found across the populatio as a whole and highest among young children and wome of childbearing age. (Table 1)

- o Except among young children, there was no strong relationship between reported iron intakes and iron status as measured by hemoglobin levels or transferri saturation levels.

Blood pressure [16]

- o Several significant and important relationships were found between blood pressure and nutritional variables. Body mass index (weight/height^2) was directly related to systolic and diastolic pressures at all ages, for both sexes and for white and black subgroups. Similar, consistent relationships were found between skinfold thickness and blood pressure, indicating that relative adiposity can be implicated as a link between blood pressure and body mass. In contrast, there were few significant or important relationships between blood pressure and reported dietary intake.

Table 1. Percent of Persons With Low Hemoglobin and Low Transferrin Saturation Levels by Sex, Race and Age, and Estimated Standard Errors: United States, 1971-1974

Race and Age	Low Hemoglobin				Low Transferrin Saturation[1]			
	Male		Female[2]		Male		Female[2]	
	Percent	Estimated Standard Error	Percent	Estimated Standard Error	Percent	Estimated Standard Error	Percent	Estimated Standard Error
All Races[3]								
ear	19	3.6	13	3.1	51	7.1	38	8.3
Years	9	1.8	8	1.8	27	3.6	24	3.6
Years	2	0.8	2	0.9	23	2.7	18	2.4
1 Years	3	0.8	3	0.9	17	1.8	13	1.6
14 Years	8	1.7	3	1.2	9	1.8	13	2.2
17 Years	2	1.0	5	1.5	6	1.7	16	2.6
44 Years	5	0.7	5	0.5	4	0.6	16	0.8
54 Years	5	1.2	5	1.1	7	1.5	10	1.6
64 Years	13	2.1	2	0.8	8	1.7	8	1.6
74 Years	15	1.3	4	0.7	4	0.8	7	0.9
White								
ear	15	3.8	11	3.4	48	8.0	37	9.7
Years	7	1.9	7	1.9	28	4.2	21	4.0
Years	1	0.7	2	1.0	22	3.3	17	2.8
1 Years	2	0.7	2	0.8	18	2.1	13	1.9
14 Years	4	1.5	2	1.1	8	2.0	12	2.5
17 Years	1	0.8	3	1.4	7	2.0	16	3.0
44 Years	5	0.7	3	0.5	4	0.7	16	0.9
54 Years	5	1.3	4	1.2	7	1.6	9	1.7
64 Years	13	2.3	1	0.5	8	1.9	7	1.7
74 Years	12	1.4	3	0.7	4	0.9	7	1.0
Black								
ear	42	8.9	22	7.4	71	13.4	53*	16.7*
Years	19	5.0	15	4.8	24	7.1	44	8.5
Years	6	3.7	3	2.0	27	5.7	23	5.0
1 Years	12	3.2	9	2.9	13	6.9	13	3.1
14 Years	30	6.3	12	4.2	13	4.4	16	4.7
17 Years	9	4.1	15	5.4	4	2.6	17	5.4
44 Years	12	2.8	16	1.9	4	1.6	21	2.0
54 Years	12	4.3	9	4.0	6	3.1	13	4.5
64 Years	17	6.4	12	4.8	6	3.7	18	5.3
74 Years	40	4.5	17	3.3	3	1.5	9	2.5

sons with a transferrin saturation below 16.0 percent and a TIBC above 250 g/dl were classified as low transferrin saturation.

es not include data for pregnant women.

udes data for races which are not shown separately.

dicates estimates that do not meet this report's standards of reliability.

Serum Cholesterol and Urate [17]

- Relative weight or body mass (weight/height^2) was found to be an important independent predictor of serum cholesterol and serum urate levels in U.S. adults as was found from blood pressure in NHANES I No dietary variables from either the 24-hour dietar recall or the food frequency questionnaire had important or consistent associations except for reported use of alcohol, which was related directly serum urate concentration.

Publications from the NHANES programs are available in th Vital and Health Statistics Series and may be purchased through the Superintendent of Documents. Increasing emphasis will be given to publishing information in professional journals and developing presentations for selected professional speciality groups. Microdata tapes for NHANES I and II will be available through the National Technical Information Service (NTIS). Most of the data fr NHANES I is already available at NTIS. The NHANES II dietary data base and the 24-hour foods consumed tapes are now available through NTIS. The summary of nutrient and caloric intake and biochemistry tapes will be sent to NTIS by February 1982. Publications of NHANES II data will beg in the summer 1982 and be completed by January 1985.

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WHAT HAS THE USDA NATIONWIDE FOOD CONSUMPTION SURVEY TOLD US?

James M. Iacono, Ph.D.
Assistant to the Deputy Administrator

National Program Staff
USDA Science and Education
Agriculture Research Service
Beltsville, MD

r. Iacono's remarks were based on a report "Problem Nutri-
nts in the United States" by Eleanor M. Pao and Sharon J.
ickle, Home Economists with the Consumer Nutrition Center,
uman Nutrition, Science and Education, U.S. Department of
griculture, Hyattsville, MD 20782. This report was pub-
ished in FOOD TECHNOLOGY, September, 1981, pp. 58-69, 79
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PROBLEM NUTRIENTS IN THE UNITED STATES

Eleanor M. Pao and Sharon J. Mickle

dentification of particular nutrients as possible problems
ased on low (or high) dietary intakes can alert specialists
ı food, nutrition, and public health to take action before
ɔnsequences become serious. However, agreement is lacking
ı the level of intake that signifies a dietary problem that
ay lead to a health problem. The Food and Nutrition Board
:ates that the Recommended Dietary Allowances (RDAs) are
:t high enough "to meet the nutritional needs of practically
.l healthy persons" (NAS/NRC, 1980). RDAs are daily amounts
f nutrients recommended for populations grouped by sex and
ge over a period of time--they are not requirements for
ɔecific individuals. Variations in requirements among
ıdividuals are unknown. The RDAs for energy are an excep-
ion and are not planned to exceed the requirements of most
ealthy individuals.

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As pointed out by Kelsay (1969), researchers have in th
utilized 80, 70, and 66.7% of the RDA as the level belo
which diets may need improvement. In the surveys condu
by the U.S. Public Health Service--the Ten-State Survey
1968-70 (HEW, 1972) and the Health and Nutrition Examin
Survey of 1971-74 (Abraham et al., 1977)--a set of stan
other than the RDA was used for evaluation of dietary i

RDAs have been set for some nutrients for which composi
values of many foods are not known. Consequently, inta
vitamin D, vitamin E, folacin, zinc, and iodine have no
estimated. Intakes of magnesium, vitamin B_6, and vitami
have been computed even though food composition values a
less reliable than for the other nutrients studied. Thu
results for these nutrients must be interpreted with res
RDAs for fat have not been established, but an upper lim
for food energy from fat has been suggested, especially
diets below 2,000 kcal (NAS/NRC, 1980, p. 36).

In the first nationwide survey of food intakes of indivi
conducted in 1965 by the U.S. Department of Agriculture,
minerals--calcium, iron, and magnesium-- and six vitamin
vitamin A value, thiamin, riboflavin, vitamin B_6, vitami
and vitamin C--averaged less than the 1968 RDA (NAS/NRC,
1968) for at least one sex-age group (USDA, 1972). Low-
income groups had average intakes for most nutrients belo
those for the population as a whole. Preliminary data ba
on 1-day dietary recall questionnaires from the spring 19
sample of the Nationwide Food Consumption Survey (NFCS) o
1977-78 indicated that the same nutrients, except ribofla
and vitamin C, averaged below the 1980 RDA for at least o
sex-age group (USDA, 1980, p. 24). Calcium, iron, magnesi
and vitamin B_6 intakes were below 70% of the RDA for seve
sex-age groups. Protein, riboflavin, niacin, and vitamin
intakes met the RDA for all sex-age groups, and phosphoru
intakes averaged slightly below the RDA for two sex-age
groups.

In this article, 3-day dietary reports only are used, and
data are for one year. The information was collected in
basic NFCS in the 48 conterminous states from April 1977
through March 1978. Of the individuals providing dietary
reports, about 90% reported for 3 days. The 3 consecutiv
days of dietary reporting consisted of a 1-day interviewe
assisted recall and a 2-day self-administered record. Th
interviewer gave oral instructions for keeping the largel
unstructured, diary-type record and helped the respondent
record foods that had already been eaten on the interview
A leaflet with pointers on how to adequately describe foo

d the quantities consumed was used during the instruction
d left with the respondent for reference. A set of stain-
ss-steel measuring cups and spoons, a plastic ruler, and a
rd listing measurement equivalents was given to each house-
ld to help in estimating amounts eaten. The interviewer
cked up and reviewed the diet records promptly after their
mpletion. Food energy and nutrient intakes of 37,785 in-
viduals (weighted count) and of 22 sex-age groups were
udied and are reported. Breastfed infants are excluded.
tamin and mineral supplements have not been included.

NUTRIENT INTAKE AS A PERCENTAGE OF THE 1980 RDA

om the 3-day intakes of energy and 12 nutrients, a 1-day
an intake was computed for each individual and expressed
a percentage of the 1980 RDA (the RDAs were interpolated
extrapolated to provide an appropriate value for each of
e 22 specified sex-age categories). The individual per-
ntages were then averaged for each sex-age group. Fre-
ency distributions were also determined.

Mean Intakes

an intakes of all sex-age groups, as shown in Table I,
ceeded the 1980 RDA for protein, riboflavin, niacin, vita-
n B_{12}, and vitamin C. Mean intakes for phosphorus, vitamin
value, and thiamin exceeded the RDA for all except one or
o sex-age groups whose intakes were over 90% of the RDA.

ing an admittedly arbitrary criterion of mean intakes of
low 70% of the RDA as an indicator, calcium, iron, magne-
um, and vitamin B_6 are problem nutrients at least for some
dividuals in certain sex-age groups. Calcium intakes of
nales 15-18 and 35-64 years of age averaged 63-69% of the
A (other groups of females over 12 years had intakes that
eraged 70-76% of the RDA, and the groups of males and
ildren had mean intakes close to 90% or more). Iron in-
kes of children 1-2 years averaged 55% of their RDA, lower
an for any other sex-age group. Females 12-50 years had
an intakes of 59-65% of the RDA (intakes of other groups
nged from 80% for children 3-5 years to 158% for males 23-
years). Magnesium intakes were 65-69% of the RDA for
nales 15-22 years (females in other age groups 12 years and
er averaged 71-80% of the RDA; males 12 years and over
eraged 77-88% of the RDA, and children under 12 years 87-
9%). Vitamin B_6 intakes ranged from 58 to 63% of the RDA
r females over 14 years and averaged 68% for males 75 years
d over (intakes of females 9-14 years averaged 75-83% of
e RDA, males 19-74 years 71-81%, and males 9-18 years and

Table 1—**MEAN NUTRITIVE VALUE OF FOOD PER INDIVIDUAL** *as a percentage of the 1980 Recommended Dietary All*

Sex and age (years)	No. of Individuals	% of RDA										
		Food energy	Protein	Calcium	Iron	Magnesium	Phosphorus	Vitamin A value	Thiamin	Riboflavin	Preformed niacin[b]	Vitamin B_6
Males and females												
Under 1[c]	421	101	183	173	156	209	220	261	244	318	132	149
1-2	1,035	101	222	102	55	129	131	172	151	209	117	118
3-5	1,719	94	203	95	80	102	123	161	138	180	136	95
6-8	1,841	84	215	114	115	99	148	149	119	161	118	91
Males												
9-11	939	81	208	104	103	88	139	132	116	145	113	93
12-14	1,150	84	194	91	82	79	123	116	117	148	117	97
15-18	1,394	92	183	98	92	77	138	124	129	152	132	93
19-22	1,068	82	176	118	155	81	188	117	105	130	123	81
23-34	2,860	90	175	107	158	88	185	114	110	126	133	80
35-50	2,664	84	167	94	156	88	170	120	105	116	130	78
51-64	2,265	87	160	93	154	88	165	141	122	136	143	78
65-74	1,118	80	141	88	142	81	150	145	114	130	127	71
75 and over	536	90	133	89	140	77	144	136	112	123	118	68
Females												
9-11	1,011	80	182	96	92	87	127	130	111	138	105	83
12-14	1,148	84	155	71	65	75	98	112	118	141	112	75
15-18	1,473	83	156	63	62	69	91	107	108	126	114	63
19-22	1,357	76	145	76	59	65	122	97	94	106	109	58
23-34	3,988	79	145	74	60	71	122	117	101	113	121	58
35-50	3,847	76	146	66	61	74	116	130	100	109	125	58
51-64	3,221	83	148	69	113	80	120	152	106	116	129	63
65-74	1,738	79	137	70	108	75	114	168	105	118	122	62
75 and over	992	89	132	74	106	75	115	128	106	120	116	61
All individuals	37,785	84	165	87	103	83	136	133	113	132	124	75

[a]The data in this and the following tables are based on 3-day dietary reports from USDA' Nationwide Food Consumption Survey, 48 conterminous 1977-March 1978

[b]Based on RDA values as milligrams of preformed niacin

[c]Excludes breast-fed infants

hildren more than 90%).

Frequency Distribution of Intakes

eans conceal the wide variations in intakes. Furthermore, hey tend to overestimate nutrient levels because an intake hat exceeds the RDA several-fold cannot be compensated for y an intake below the RDA. The percentage of intakes found o be below the RDA or a given percentage of the RDA, how- ver, may be unduly high if the reporting period is short.

ietary information in NFCS 1977-78 was collected for 3 days, artly to provide a 1-day mean intake suitable for use in requency distributions. The 1-day mean nutrient intakes of ndividuals, expressed as a percentage of the appropriate DA, were distributed into three categories--(1) 100% and ver, (2) 70-99%, and (3) less than 70%--as shown in Table . The frequency distributions, as did the means, signify hat of the nutrients considered, calcium, iron, magnesium, nd vitamin B_6 pose the greatest dietary problems. For hese nutrients, 42, 32, 39, and 51%, respectively, of in- ividuals studied had intakes of less than 70% of the their DA. Vitamin A and vitamin C may be problems also, with 31 nd 26% of intakes below 70% of RDA; however, one-half or ore of the intakes met or exceeded the RDA, indicating that hey might have appeared to be less of a problem had the eporting time been longer. Protein, phosphorus, and niacin ppear to pose the least problem, with fewer than 10% of ntakes below the 70% RDA level.

nutrient may be a "problem" in one sex-age group and not n another. Calcium intakes of 51-62% of females in age oups over 11 years were in the lowest intake category, as re 36-38% of the intakes of males 35 years and older able 3). With the change in RDA for calcium from 800 mg r preteens to 1,200 mg for the teenage years, the pro- rtion of teenagers in the lowest intake category increased arply over that for the preteens. For girls, the pro- rtion doubled from 25 to 51%. Iron intakes were below % of the RDA for 82% of the 1- to 2-year-olds and for -73% of the females in age groups of 12-50 years; between and 38% of the infants, 3-5 year-olds, and boys 12-14 ars old had iron intakes in the lowest category. Magne- um intakes were in the lowest category for 41-62% of males over 11 years and 43-44% of males 12-22 and over 74 ars. Vitamin A values were in the low category for 25- % of the teenagers and most groups of adults. Vitamin B_6 takes of the majority (66-73%) of females over 14 years re in the lowest category, as were those of 42-46% of

Table 2--PERCENTAGE DISTRIBUTION of 37,785 indivi
with nutrient intakes at specified levels of 1980

Nutrient	% of individuals receiving: 100% and over of RDA	70-99% of RDA	Less than 70% of RDA
Energy	24	44	32
Protein	88	9	3
Calcium	32	26	42
Iron	43	25	32
Magnesium	25	36	39
Phosphorus	73	19	8
Vitamin A value	50	19	31
Thiamin	55	28	17
Riboflavin	66	22	12
Preformed niacin[a]	67	24	9
Vitamin B_6	20	29	51
Vitamin B_{12}	66	19	15
Vitamin C	59	15	26

[a]Based on RDA values as milligrams of preformed niacin

young and middle-aged men and 54-58% of the oldest men. Vitamin C intakes of 22-26% of the preschoolers, 21-31% the men, and 22-43% of the women were in the low-level category.

Individuals were also compared according to demographic characteristics (Table 4). Among regions, a higher pro portion of people in the South had calcium, iron, magne vitamin A, vitamin B_6, and vitamin C intakes below 70% the RDA than in the other regions. Regarding urbanizat slightly more of the individuals in central cities had low intakes of calcium and magnesium, slightly more of in suburban areas had low intakes of iron, and slightly higher proportions of people in the nonmetropolitan are had the low intakes of vitamin A, vitamin B_6, and vitam Blacks had a larger proportion of intakes for five of t six nutrients in the lowest group, compared to whites. Among income groups, the highest proportions of low int were in the low-income group, except for iron.

TABLE 3—PERCENTAGE DISTRIBUTION, BY SEX AND AGE, OF INDIVIDUALS with nutrient intakes at designated levels of the RDA

Sex and age (years)	No. of individuals	Calcium		Iron		Magnesium		Vitamin A value		Vitamin B		Vitamin C	
		< 100% of RDA	< 70% of RDA	< 100%	< 70%	< 100%	< 70%	< 100%	< 70%	< 100%	< 70%	< 100%	< 70%
Both sexes													
[illegible]	4,311	[illegible]	4	40	10	69	3	88	4	80	9	82	11
[illegible]	[illegible]	47	26	4	82	74	7	72	12	63	12	61	28
[illegible]	1,116	41	30	18	28	48	16	69	13	39	28	64	22
[illegible]	1,641	61	14	64	6	46	18	63	17	36	27	73	4
Males													
[illegible]	[illegible]	49	21	46	12	30	27	62	26	36	26	76	11
[illegible]	[illegible]	36	32	22	36	19	43	46	33	39	28	70	16
[illegible]	[illegible]	43	29	33	24	19	44	48	32	37	28	66	20
[illegible]	[illegible]	53	24	86	3	26	43	36	44	26	46	58	27
[illegible]	[illegible]	47	28	89	2	31	32	41	39	23	42	66	28
[illegible]	[illegible]	36	36	89	2	30	30	44	35	20	44	66	29
[illegible]	[illegible]	36	36	87	3	31	29	53	30	20	43	63	21
[illegible]	[illegible]	32	38	83	2	23	38	54	30	14	54	63	23
[illegible]	[illegible]	35	38	79	6	17	44	61	34	12	58	56	3
Females													
[illegible]	[illegible]	42	25	33	21	28	27	50	24	25	35	71	14
[illegible]	[illegible]	15	51	6	64	16	45	42	34	18	47	63	21
[illegible]	[illegible]	13	62	7	70	12	56	39	41	10	67	51	32
[illegible]	[illegible]	25	51	6	73	10	62	34	46	6	72	44	43
[illegible]	[illegible]	23	55	5	72	15	54	41	40	7	73	48	38
[illegible]	[illegible]	16	61	5	71	15	48	46	36	6	73	51	34
[illegible]	[illegible]	18	57	59	11	22	41	57	26	9	66	63	24
[illegible]	[illegible]	18	57	54	13	15	45	61	22	8	67	66	22
[illegible]	[illegible]	21	51	50	14	16	47	44	36	8	69	60	26

[illegible]

TABLE 4—PERCENTAGE DISTRIBUTION OF INDIVIDUALS IN SPECIFIED DEMOGRAPHIC GROUPS with [illegible] of the 100% RDA

Demographic group	No. of individuals	Calcium		Iron		Magnesium		Vitamin A value		Vitamin B		Vitamin C	
		< 100% of RDA	< 70% of RDA	< 100%	< 70%	< 100%	< 70%	< 100%	< 70%	< 100%	< 70%	< 100%	< 70%
Region													
[illegible]	9,259	32	41	43	32	24	38	50	30	19	50	66	22
[illegible]	10,125	35	39	44	32	26	37	49	31	20	51	60	26
[illegible]	11,734	25	49	42	33	20	45	46	36	17	55	53	31
[illegible]	6,667	40	35	46	31	35	30	56	25	24	46	61	25
Metropolitan [illegible]													
[illegible]	11,177	29	44	44	31	24	41	52	30	20	50	61	25
[illegible]	14,188	34	40	43	33	27	36	51	30	20	50	61	25
[illegible]	12,420	32	42	43	32	25	39	46	34	18	52	55	29
Age													
[illegible]	31,591	34	40	44	32	27	36	50	31	19	51	59	26
[illegible]	[illegible]	18	56	37	36	15	55	51	34	19	54	59	26
Urban													
[illegible]	[illegible]	25	49	43	29	20	48	46	36	16	59	55	30
[illegible]	4,498	31	43	46	31	24	40	48	33	18	51	56	29
[illegible]	[illegible]	34	39	43	33	28	36	50	32	21	49	58	27
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

ENERGY AND RELATIONSHIP TO OTHER NUTRIENTS

Among the sources of food energy, fat has been of specia concern because of possible association with heart disea and obesity. The Food and Nutrition Board (NAS/NRC, 198 p. 36) has suggested that total fat intake, particularly diets below 2,000 kcal, should provide no more than 35% energy. Participants in this study averaged 41% of thei food energy from nutrient fat. As shown in Table 5, infa and children averaged the lowest (37-38%) and men 35-50 years the highest (43%). In the USDA survey of individua intakes in 1965 (USDA, 1972, p. 13), the percentage of fo energy from fat ranged from 39% for infants to 45% for me 26-64 years. These results thus indicate a downward tren

The distribution of individuals by level of food energy f fat reveals that one-fifth of all individuals had intakes with less than 35% of energy from this source. One-fourt of the individuals obtained 45% or more of their food ene from fat. Of the men 35-64 years, over one-third had 45% or more of their food energy coming from fat. The propor- tion of women in the 45% and over categories was less than for men. Considerably fewer children (just over one-tenth were in this high fat category.

Recommended energy intakes in the 1980 RDAs are expressed as a midpoint and a range for men, women, and children of different ages. The midpoints of the ranges are the basis for the RDA values (interpolated) used here for comparisons Mean intakes of food energy by sex-age groups varied from 76% of the RDA for females 19-22 and 35-50 years to 101% of the RDA for infants and 1 to 2-year-olds (Table 1). About one-fourth of all individuals had intakes that exceeded the RDA (Table 2).

Individuals with diets low in caloric content may have dif- ficulty obtaining sufficient amounts of nutrients. Pre- liminary data from the NFCS indicated that caloric intakes have decreased compared with the USDA survey in 1965 (Pao, 1981). Also, about 10% of the participants reported that they were on special diets, and their intakes were lower in calories on the average than for the total group (Rizek and Jackson, 1980). To study nutrient content of diets that met the RDA for energy and those that were below 70% of the RDA, the intakes of food energy were distributed int the appropriate categories. The mean nutrient contents of diets in the highest and lowest energy intake groups are contrasted for all individuals and for five specified sex- age categories in Table 6.

MEANS AND PERCENTAGE DISTRIBUTION OF INDIVIDUALS *with intakes which provide specified levels of food energy from fat*

Sex and age (years)	No. of individuals	Mean % of food energy from fat	% of individuals receiving: < 30% of food energy from fat	30-34.99%	35-39.99%	40-44.99%	45-49.99%	≥ 50%
Males and females								
[illegible]	421	36.5	22.5	16.8	21.5	21.7	16.1	1.4
1-2	1,035	37.7	10.8	22.6	31.9	22.2	9.8	2.7
3-5	1,719	37.8	8.5	21.3	35.4	24.0	8.6	2.1
6-8	1,841	38.4	5.3	19.0	37.6	28.4	8.0	1.7
Males								
9-11	939	39.2	5.0	16.1	35.7	31.3	9.4	2.5
12-14	1,150	39.5	3.9	14.0	38.2	30.2	10.3	3.4
15-18	1,394	40.6	2.9	14.0	28.0	33.4	16.9	4.7
19-22	1,068	40.9	5.0	13.4	25.8	27.8	19.4	8.6
23-34	2,860	41.6	4.7	11.5	21.9	31.8	21.1	9.1
35-50	2,664	42.7	4.1	8.9	21.1	30.0	22.1	13.9
51-64	2,265	42.4	3.4	11.0	22.2	27.7	22.7	12.9
65-74	1,118	40.7	7.3	11.8	28.2	26.1	17.3	9.4
75 and over	536	40.6	8.2	14.5	26.1	21.4	16.1	13.5
Females								
9-11	1,011	38.7	6.0	17.8	35.1	29.7	9.3	2.2
12-14	1,148	39.3	5.3	17.0	33.5	29.2	11.2	3.8
15-18	1,473	40.0	5.4	16.0	28.2	30.3	13.9	6.2
19-22	1,357	40.4	7.4	15.2	24.4	28.0	15.3	9.7
23-34	3,988	41.0	6.3	12.4	25.3	28.4	17.7	10.0
35-50	3,847	41.9	5.1	11.7	22.7	26.9	21.1	12.5
51-64	3,221	41.3	6.2	11.3	24.9	29.7	17.7	10.2
65-74	1,738	39.2	9.4	16.7	29.1	24.5	14.2	6.1
75 and over	992	38.8	10.5	18.5	28.6	21.9	14.7	5.8
All individuals	37,785	40.5	6.1	14.0	27.2	28.1	16.5	8.1

[illegible] Excludes breastfed infants

Table 6—**MEAN NUTRITIVE VALUE OF FOOD PER INDIVIDUAL** *as a percentage of 1980 RDAs by food energy level of intake*

	Mean nutritive value as % of RDA											
	Among those receiving ≥ 100% of RDA for food energy						Among those receiving < 70% of RDA for food energy					
Nutrient	All individuals (N = 9,350)	Children 1-2 yr (N = 502)	Boys 12-14 yr (N = 260)	Men 35-50 yr (N = 643)	Girls 15-18 yr (N = 368)	Women 35-50 yr (N = 572)	All individuals (N = 11,915)	Children 1-2 yr (N = 155)	Boys 12-14 yr (N = 342)	Men 35-50 yr (N = 837)	Girls 15-18 yr (N = 480)	Women 35-50 yr (N = 1,637)
Energy	121	125	120	121	121	118	55	59	57	56	54	53
Protein	226	267	266	229	219	212	115	141	138	122	106	110
Calcium	123	120	132	138	91	97	57	67	60	62	40	48
Iron	142	66	113	213	87	87	71	37	59	114	42	46
Magnesium	116	154	112	121	99	102	58	79	53	64	47	57
Phosphorus	190	157	173	240	130	168	93	83	84	118	61	87
Vitamin A value	170	198	158	154	159	164	103	129	79	98	72	108
Thiamin	159	183	161	145	156	151	76	93	85	72	70	73
Riboflavin	186	246	209	165	183	158	89	139	105	81	81	81
Preformed niacin*	166	141	158	175	159	175	91	73	87	96	79	97
Vitamin B_6	105	141	133	107	90	83	51	73	69	56	42	44
Vitamin B_{12}	230	216	279	255	205	207	129	130	151	147	94	125
Vitamin C	195	193	246	174	175	170	106	104	129	103	85	101

*Based on RDA values as milligrams of preformed niacin

The energy value of diets that met the RDA for energy av aged 113-129% of the RDA, depending on the sex-age group One-fourth of all individuals had energy intakes above t RDA, as did almost one-half of the infants and 1- to 2-y olds; over one-third of the 3- to 5-year olds, 15- to 18- year-old boys, and adults over 74 years; and one-sixth of the 9- to 11-year olds, females 19-22 and 35-50 years, a men 65-74 years. For these diets with energy intakes meeting the RDA, mean intakes of nutrients were well abov the RDA for most nutrients and at least 80% of the RDA fo all nutrients. Not surprisingly, those below the RDA for some sex-age groups were calcium, iron, magnesium, and vitamin B_6. The exception was iron intakes of the 1- to year-olds, which provided only 66% of the RDA.

One-third of the individuals had intakes with caloric con- tent below 70% of the RDA. Included in this group were t fifths of the women 19-50, a smaller fraction of males, a even fewer of the children. For these low-caloric diets, mean intakes of calcium, iron, magnesium, and vitamin B_6 values for some sex-age groups were in the range of 40-60% of the RDA (Table 6). The diets of the small group of 1- 2-year olds with low-caloric intakes had an iron content that was 37% of the RDA. In addition to these nutrients recognized as potential problems earlier, others are ident fied here as potential problems for individuals who contin on these low-caloric intakes for long periods. For exampl girls 15-18 years met the RDA for only one of the 12 nutri- ents studied--protein--and most other individuals for only four or five of the nutrients.

FOOD SOURCES OF PROBLEM NUTRIENTS

Foods reported in the NFCS were organized into major food groups. Mixtures were put into the food group of the majo component; for example, milk is an ingredient in cream of tomato soup, but this soup is included with the food group, tomatoes. After appropriate codes were assigned to each food item, its nutrient values were computed, and the per- centage of nutrient from each of several food groups was determined for each individual. Individual intakes were then sorted into those that met the RDA, were 70-99% of the RDA, or were below 70% of the RDA. Then the mean percent- age of nutrient from each food group was calculated for each sex-age group. Food sources of the highest nutrient intake groups (i.e., that met the RDA for the nutrient) are compared with food sources of nutrients in the lowest intak groups (less than 70% of the RDA) for the three minerals an three vitamins most likely to be problems.

Calcium

Individuals with the highest intakes of calcium received 67% of the mineral from milk and milk products, in contrast to the 35% of total intake for individuals with the lowest intakes (Table 7). Children and teenagers with the highest intakes received 70-80% and those with the lowest intakes about 50% of their calcium from the milk group. Women with the highest intakes derived about 65% and those with the lowest intakes derived about 33% from this source. For men with the lowest calcium intakes, grain products (27-33%) were the primary source, and milk and milk products (21-28%) were secondary. The fruits/vegetables group (including legumes) and meats/eggs group (including meat, poultry, fish, eggs, and their mixtures) were more prominent as sources of calcium in the lowest intakes than in the highest intakes.

Iron

Over 40% of all individuals met the RDA for iron, and most of the men (79-89%) and over one-half of the infants, children, and older women were included (Tables 2 and 3). One-third (32%) of all individuals were in the group with lowest intakes. Most of the 1- to 2-year-olds (82%) and 12- to 50-year-old females (64-73%), almost two-fifths (38%) of the 3- to 5-year-olds, and almost one-third (30%) of the infants were in the lowest intake groups.

For the group as a whole, the meats/eggs and grain products groups contributed most (69-72%) of the dietary iron in both the highest and lowest intake groups (Table 8). The fruits/vegetables group contributed 18% of the total iron in both as well. However, there were considerable differences between sex-age categories in the highest and lowest intakes of iron.

Infants having the highest intakes received 90% of their iron from two food groups--the milk group (41%) and the grain products group (49%), reflecting use of iron-fortified formulas and baby cereals. Infants having the lowest intakes derived more of their iron from grain products (39% of their total intake) than from the milk group (17%). The meats/eggs and fruits/vegetables groups contributed consequential amounts of iron in infant diets lowest in this nutrient. (Availability of iron and impact of accompanying meal components are not considered here.)

The few 1- to 2-year-olds in the highest iron-intake group acquired about 65% of the nutrient from grain products, much

Table 7—**FOOD SOURCES OF CALCIUM IN DIETS** *that met or had less than 70% of the RDA for calcium*

Sex and age (years)	% of total intake [a]								
	Milk group[b]		Meats/eggs group[c]		Grain products[d]		Fruits/vegetables[e]		Fats/sweets
	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes
Males and females									
Under 1	74	81	2	4	14	7	9	7	—[g]
1-2	80	55	4	10	10	19	5	12	1
3-5	75	52	4	9	14	24	6	11	1
6-8	72	49	4	9	15	27	7	12	1
Males									
9-11	71	50	5	10	16	25	7	11	2
12-14	72	50	4	10	16	26	6	11	2
15-18	70	42	6	14	16	27	6	13	2
19-22	63	25	8	20	19	32	8	16	2
23-34	60	24	8	19	20	32	9	17	3
35-50	57	21	9	20	19	32	11	19	3
51-64	58	26	8	19	19	27	11	21	3
65-74	62	27	7	17	17	30	11	20	2
75 and over	61	28	7	17	18	33	13	17	2
Females									
9-11	72	53	4	8	15	25	7	11	1
12-14	74	51	4	9	15	24	6	11	2
15-18	74	48	4	12	14	24	6	12	2
19-22	67	36	7	15	16	27	8	15	2
23-34	66	34	6	15	16	26	9	17	3
35-50	64	29	6	16	15	27	11	20	3
51-64	65	31	7	15	14	26	12	21	2
65-74	67	34	5	12	14	27	12	21	2
75 and over	65	37	5	11	15	28	13	18	2
All individuals	67	35	6	15	16	27	9	17	2

[a]Highest intakes provide 100% of the RDA or more; lowest intakes, less than 70% of the RDA
[b]Milk, cheese, ice cream, and mixtures
[c]Meat, poultry, fish, eggs, and mixtures
[d]Cereals, breads, other bakery products, and mixtures
[e]Fruits, vegetables, legumes, nuts, and mixtures
[f]Fats, oils, salad dressings, sugar, sweets, alcoholic and nonalcoholic beverages
[g]Less than 0.5% but more than 0

Table 8—**FOOD SOURCES OF IRON IN DIETS** *that met or had less than 70% of the RDA for iron*

Sex and age (years)	% of total intake [a]									
	Milk group		Meats/eggs group		Grain products		Fruits/vegetables		Fats/sweets/bev	
	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lo int
Males and females										
Under 1	41	17	3	17	49	39	7	21	—[b]	
Under 1-2	6	6	12	31	65	38	15	18	1	
3-5	4	5	29	30	47	41	16	16	3	
6-8	4	5	30	31	43	41	17	14	3	
Males										
9-11	4	5	32	35	43	37	17	16	3	
12-14	4	5	30	35	44	39	18	15	3	
15-18	4	4	37	40	39	35	15	15	4	
19-22	3	3	44	41	31	30	16	17	4	
23-34	3	3	44	45	30	23	16	16	5	
35-50	2	3	44	46	28	29	18	12	6	
51-64	2	1	43	44	29	24	19	21	5	
65-74	2	4	38	37	33	31	20	18	5	
75 and over	2	5	37	40	34	33	20	10	4	
Females										
9-11	4	5	31	31	42	41	19	16	3	
12-14	3	5	30	35	46	37	17	16	3	
15-18	3	4	35	39	39	33	19	16	3	
19-22	2	3	36	40	38	30	20	18	3	
23-34	3	3	37	40	34	28	21	19	4	
35-50	2	2	40	41	32	27	20	19	5	
51-64	2	2	39	36	30	26	21	23	5	
65-74	2	2	36	33	33	31	22	23	5	
75 and over	2	3	32	33	37	35	23	19	4	
All individuals	3	4	39	38	33	31	18	18	5	

[a]Highest intakes provide 100% of the RDA or more, lowest intakes, less than 70% of the RDA
[b]Less than 0.5% but more than 0

of it probably from cereals. The large number of 1- to 2-year-olds with the lowest iron intakes obtained a much smaller proportion of their iron from grain products--38%. The 3-to 5-year-olds with the highest iron intakes acquired only a slightly higher proportion from grain products than did those with iron intakes below 70% of the RDA.

Females 12-50 years having the highest iron intakes and those having the lowest intakes both depended on the meats/eggs and grain products groups for most of their iron (62-76% of total intake). However, the highest intake group derived a larger proportion from grain products and a slightly smaller proportion from the meats/eggs group than did the lowest intake group. Both groups obtained about 15-20% of their iron from the fruits/vegetables group, of which legumes contributed proportionately more to the highest intakes than to the lowest intakes.

Magnesium

Individuals in the highest intake group for magnesium were most of the infants, many of the children, almost one-third of the men under 65 years, and fewer from the other sex-age categories (Table 4). The lowest intake group was made up mostly of teenagers and adults.

Among children and teenagers, milk and milk products contributed nearly one-third of the magnesium in the highest intake group and somewhat less (closer to one-fourth) in the lowest intake group (Table 9). Grain products supplied about the same proportion (one-fourth) of magnesium in both the highest and lowest intake categories. In general, for all sex-age categories, the fruits/vegetables group contributed more heavily and the meats/eggs group less heavily to the highest intakes of magnesium than to the lowest intakes of magnesium.

Among adults, as among younger individuals, the meats/eggs group was a considerably more important source of magnesium for those with the lowest intakes (17-27% of total intake) than for those with the highest intakes (10-17%). Nevertheless, the fruits/vegetables group provided the largest source of magnesium in both the highest and lowest intakes. Beverages (mainly coffee) also made a sizable contribution of magnesium to both the highest and lowest intakes--up to 25% of the total intake for some sex-age categories. The milk group was less important as a source of magnesium for adults than for children, but it was as important as the meats/eggs group for individuals in several sex-age

Table 9—**FOOD SOURCES OF MAGNESIUM IN DIETS** *that met or had less than 70% of the RDA for magnesium*

	% of total intake[a]								
	Milk group		Meats/eggs group		Grain products		Fruits/vegetables		Fats/swee
Sex and age (years)	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes
Males and females									
Under 1	50	86	5	1	20	3	23	8	—[b]
1-2	37	26	12	19	22	23	26	26	2
3-5	31	25	12	20	26	26	28	25	2
6-8	31	27	13	18	25	26	29	23	2
Males									
9-11	29	26	13	20	26	25	28	23	3
12-14	30	25	12	20	27	25	28	24	3
15-18	29	21	15	24	27	23	25	24	4
19-22	21	16	17	27	22	22	27	24	12
23-34	15	12	17	27	22	20	26	23	19
35-50	12	9	17	26	20	20	26	24	25
51-64	13	10	15	25	22	18	27	26	23
65-74	12	12	14	23	26	20	29	26	18
75 and over	12	13	12	20	25	22	35	24	14
Females									
9-11	28	26	13	18	24	26	32	24	2
12-14	28	23	13	20	25	25	29	25	3
15-18	27	21	15	23	23	23	30	25	5
19-22	18	16	14	24	23	21	34	26	11
23-34	16	13	14	23	22	20	29	26	19
35-50	12	10	15	22	20	18	27	26	25
51-64	12	9	14	21	21	18	31	28	21
65-74	13	11	12	18	26	20	31	29	17
75 and over	15	15	10	17	30	21	32	26	13
All individuals	22	15	14	23	23	21	28	25	12

[a]Highest intakes provide 100% of the RDA or more; lowest intakes, less than 70% of the RDA
[b]Less than 0.5% but more than 0

Table 10—**FOOD SOURCES OF VITAMIN B_6 IN DIETS** *that met or had less than 70% of the RDA for vitamin B_6*

	% of total intake[a]								
	Milk group		Meats/eggs group		Grain products		Fruits/vegetables		Fats/sweets/b
Sex and age (years)	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes
Males and females									
Under 1	49	57	10	10	14	8	24	19	—[b]
1-2	19	23	28	32	25	16	26	23	1
3-5	14	18	28	33	33	23	23	22	1
6-8	14	18	28	35	33	22	23	22	1
Males									
9-11	13	16	29	36	34	24	22	21	1
12-14	14	15	31	40	32	22	21	20	1
15-18	13	13	36	46	28	17	21	20	1
19-22	9	10	42	50	19	15	23	21	6
23-24	7	8	44	51	17	13	23	22	7
35-50	6	6	45	52	15	13	26	23	7
51-64	6	7	41	49	20	13	28	26	4
65-74	7	9	31	45	30	16	28	27	2
75 and over	6	9	31	43	30	17	31	27	1
Females									
9-11	12	17	29	34	32	24	25	21	1
12-14	12	15	31	39	34	20	22	22	—[b]
15-18	11	13	34	43	29	18	24	22	1
19-22	8	10	38	47	23	15	28	24	3
23-34	9	9	38	48	21	14	29	25	3
35-50	7	7	41	49	21	13	29	27	1
51-64	6	7	40	46	21	13	30	30	2
65-74	6	9	33	40	26	17	33	31	—[b]
75 and over	7	10	29	39	28	17	35	30	—[b]
All individuals	13	10	34	46	26	15	25	25	2

[a]Highest intakes provide 100% of the RDA or more; lowest intakes, less than 70% of the RDA
[b]Less than 0.5% but more than 0

ategories having the highest intakes.

Vitamin B_6

ore children and teenage boys had intakes of vitamin B_6 hat met the RDA than had intakes below 70% of the RDA Table 3). The opposite was true for teenage girls and dults, with few women having intakes that met the RDA.

s shown in Table 10, for all individuals having the highest ntakes of vitamin B_6, the meats/eggs group was the most lentiful source (34%), and grain products was the next most mportant group (26%). Individuals with the lowest intakes f vitamin B_6 derived 46% of this nutrient from the meats/ ggs group, but grain products were much less important as a ource (15%). The fruits/vegetables group provided 25% of he vitamin B_6 in both the highest and lowest intakes. The ilk group was a less important source, as was the fats/ weets/beverages group.

Vitamin A Value

everal food groups were separated into subgroups because f the differences in the subgroups' contributions to the ighest and lowest intakes of vitamin A value (Tables 11 and 2). Legumes, sweets, and beverages were omitted because of heir low contributions to vitamin A value (1% or less, except for infants and young children).

egetables were the major contributors of vitamin A value hereafter written as vitamin A) for the highest intakes nd for the lowest intakes as well. Overall, 42% of the itamin A in the highest intakes group came from vegetables, ith 25% coming from the dark-green and deep-yellow kinds nd smaller but substantial amounts from other vegetables 17%). Contributions from vegetables were less in the diets f infants, children, and some teenagers (27-40%) than in iets of adults (41-51%). Individuals with the lowest in- kes of vitamin A derived about one-half as much (22%) of heir vitamin A from vegetables as individuals with the high- st intakes, although proportions varied among specific sex- ge categories.

he next most important sources of vitamin A--the milk, meat, rain products, and the combined fruits/tomatoes groups-- iffered in their contribution to highest and lowest intakes. n the highest intakes as a whole, these four food groups ontributed about equally (12-14%) to account for over one- alf of the vitamin A. The most important of these four

Table 11—**MILK, MEATS, EGGS, GRAINS, AND FATS/OILS SOURCES OF VITAMIN A VALUE** *in diets that met or had less tha RDA for vitamin A*[a]

Sex and age (years)	% of total intake[b]								
	Milk group		Meat group		Eggs		Grain products		Fats
	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highes intakes
Males and females									
Under 1	45	66	8	8	1	2	3	7	—
1-2	25	31	11	6	3	9	18	20	3
3-5	20	30	10	7	3	9	25	24	5
6-8	19	31	10	7	2	5	23	25	4
Males									
9-11	16	29	12	8	2	5	21	27	4
12-14	16	27	12	10	2	5	20	27	4
15-18	17	27	14	11	2	7	19	20	5
19-22	12	23	20	14	3	7	13	18	4
23-34	11	20	16	13	3	8	11	15	4
35-50	9	16	15	13	3	9	9	14	5
51-64	8	18	18	12	3	10	9	11	5
65-74	8	17	17	12	2	10	11	15	4
75 and over	7	18	15	8	3	15	11	14	4
Females									
9-11	16	29	10	8	2	5	20	26	4
12-14	15	29	13	9	2	5	19	23	4
15-18	14	25	13	13	2	5	15	20	4
19-22	11	22	12	13	2	6	13	17	4
23-34	10	19	14	13	2	6	10	16	4
35-50	7	17	15	11	2	7	8	14	4
51-64	7	16	15	9	2	8	8	14	4
65-74	7	18	14	8	2	7	10	14	4
75 and over	7	18	15	7	1	7	8	16	4
All individuals	13	21	14	11	2	7	13	17	4

[a]Legumes, sweets, and beverages were omitted because their combined contribution was 1% or less, except for infants (4%) and 1- to 5-year-olds (2
[b]Highest intakes provide 100% of the RDA or more; lowest intakes, less than 70% of the RDA
[c]Less than 0.5% but more than 0

Table 12—**FRUIT AND VEGETABLE SOURCES OF VITAMIN A VALUE** *in diets that met or had less than 70% of the RDA for vi*

Sex and age (years)	% of total intake[a]							
	Citrus fruit, tomatoes		Noncitrus fruits		Dark-green, deep-yellow vegetables		Other vegetab	
	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	Lowest intakes	Highest intakes	
Males and females								
Under 1	1	1	4	2	22	—[b]	13	
1-2	6	8	5	4	15	1	13	
3-5	7	8	4	3	15	1	12	
6-8	5	8	5	4	19	1	14	
Males								
9-11	5	9	5	2	22	1	13	
12-14	4	8	5	3	24	1	13	
15-18	5	9	4	2	21	1	13	
19-22	5	10	4	2	25	2	16	
23-34	7	10	5	2	26	2	18	
35-50	6	10	5	2	27	3	20	
51-64	7	11	7	3	25	3	19	
65-74	5	11	8	4	28	3	16	
75 and over	5	10	8	3	33	3	14	
Females								
9-11	5	8	6	3	22	1	15	
12-14	6	9	6	3	22	1	14	
15-18	6	10	6	3	25	1	15	
19-22	7	11	6	3	26	1	18	
23-34	7	11	6	3	28	3	20	
35-50	7	12	7	3	29	3	20	
51-64	7	12	9	4	29	3	19	
65-74	7	15	10	4	31	4	17	
75 and over	5	11	8	6	36	5	15	
All individuals	6	11	6	3	25	2	17	

[a]Highest intakes provide 100% of the RDA or more; lowest intakes, less than 70% of the RDA
[b]Less than 0.5% but more than 0

ources for children over 2 years and teenagers was grain roducts--mostly because of the use of fortified ready-to- at cereals. Also, the milk group provided considerably ore vitamin A in diets of infants, children, and teenagers han did the meat group or the combined fruits/tomatoes roup. For adults, the meat group and the combined fruits/ omatoes groups contributed more vitamin A than the other wo food groups. Grain products contributed slightly more itamin A than did the milk group in diets of older infants.

n diets with the lowest vitamin A content, for individuals verall, the milk group (21%) was as important as the com- ined vegetable groups (22%). But the grain products group 17%), the fruits/tomatoes group (14%), and the meat group 11%) were less important. Also, fats and oils (8%) and ggs (7%) made contributions that should not be overlooked. s before, the picture varied among sex-age groups. The ilk group was the largest contributor of vitamin A in diets f infants, children, and teenagers with the lowest intakes. rain products were the next most important source, although ruits were more important for some older adult groups. Gen- rally, the combination of citrus and noncitrus fruits and omatoes was also more important as a source than the meat roup.

Vitamin C

ne largest source of vitamin C in diets with the highest itamin C content was the citrus fruit/tomatoes group, pro- iding 42% of the total amount (no table). Noncitrus fruits, hite potatoes, and other vegetables (excluding dark-green nd deep-yellow kinds) each provided an additional 10% of e total vitamin C. Grain products (6%) and nonalcoholic verages (7%) also contributed small amounts. In diets th the lowest content of vitamin C, vegetables were the st important source. Almost one-fourth (23%) of the tamin came from white potatoes, and an additional 18% me from other vegetables. The combined fruits and matoes group (15%), grain products (10%), milk group (9%), d meat group (8%) contributed most of the rest of the tamin C. However, the milk and grain products groups were re important sources for infants, children, and teenagers an for adults, and the fruits, vegetables, and meat groups re more important for adults.

SUMMARY

Of the nutrients studied, calcium, iron, magnesium, and vi min B_6 intakes of at least one-third of the individuals w below 70% of the RDA, and mean intakes were below 70% of RDA for several sex-age groups. For vitamin A and vitami C, one-fourth to one-third of the individuals had intakes below 70% of the RDA, even though intakes averaged close or exceeded the RDA. Intakes most often below the RDA we calcium and magnesium intakes of females 12 years and ove iron intakes of 1- to 2-year-olds and females 12-50 years and vitamin B_6 intakes of females over 14 years and males over 64 years. In four-fifths of the diets, fat provided 35% or more of food energy, and more men than women or children had such diets.

Food sources that contributed the most to nutrient intake generally differed between the highest and lowest intakes. Calcium in the highest intakes (i.e., meeting or exceedin the RDA) came mainly from the milk group (67% of total ca cium intake), with much less from grain products (16%); i the lowest intakes (less than 70% of the RDA), the milk group (35%) provided much less and grain products (27%) m with the fruits/vegetables (17%) and meats/eggs (15%) grou contributing substantially. Iron sources in both the high est and lowest intakes of individuals as a whole were simi However, for infants with the highest intakes, the milk gr (41%) contributed nearly as much as grain products (49%); for infants with the lowest intakes, the milk group (17%) provided much less than did grain products (39%). Magnesi in the highest intakes came more from the milk group (22%) and less from the meats/eggs group (14%) than in the lowes intakes (15 and 23%, respectively); but for the highest an lowest intakes, it came about equally from the fruits/veg- etables group (28 and 25%, respectively) and grain product (23 and 21%, respectively). Vitamin B_6 in the highest in- takes came about evenly from three food groups--meats/eggs (34%), grain products (26%), and fruits/vegetables (25%)-- but in the lowest intakes, meats/eggs (46%) predominated. Vitamin A value in the highest intakes came more from dark green and deep-yellow vegetables (25%) than other food groups, but in the lowest intakes very little came from th source (2%). Vitamin C in the highest intakes came predom inantly from the citrus fruit/tomatoes group (42%) but in the lowest intakes predominantly from vegetables (44%), on half from potatoes (23%).

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HAS OUR DIET CHANGED?

Alvin M. Riley, Jr.
Horace S. Schwerin
Barbara E. Brett

Campbell Soup Company
Campbell Place
Camden, NJ 08101

The subject of addition of nutrients to foods cannot ully be resolved without first understanding how and what icans are actually eating today. Foods are not consumed e but in combination with other foods, and the proportions in these combinations determine whether or not the popula-, and segments within it, are being provided an adequate ly of nutrients.

The purpose of this article, therefore, is to provide a print of the foundation upon which a sound nutrient for-cation structure can and should be built. All that can one in the allotted space is to offer an overview, with indication of how cereals and grains fit into the larger me of things.

THE PRIMARY SOURCE DATA

The source of what follows is the Campbell Soup Company rmation bank, in which data from a number of government private sector dietary and food-related surveys have been grated and systematized. For the present review, three r government surveys incorporated in the bank and encom-ing a ten-year span have been drawn upon. These are the State Nutrition Survey (1968-70) and the First Health and ition Examination Survey (1971-74), both under the aus-s of the then Department of Health, Education, and Welfare; the Nationwide Food Consumption Survey (1977-78), directed e Department of Agriculture. Henceforth, these three eys are referred to respectively as Ten-State, HANES I, NFCS.

Each of the surveys collected one-day dietary records of precise kinds and amounts of foods consumed by individuals ng the preceding 24 hours by means of interviews; in tion, NFCS obtained two immediately following days of

diary reports from the same individuals.

Extensive information on the nutrition-related hea status of the respondents was also gathered in the two surveys; not directly pertinent to the present account, fully described elsewhere (Schwerin et al., 1981a and l where more extensive treatment of the methodology and f will also be found.

HANES I and NFCS were representative samples of th population of the 48 conterminous states, with the exce that the former did not include infants under one year persons over 74 years of age. Ten-State, as the name i cates, was limited to selected states in all sections o country; moreover, it concentrated on four segments con to be at nutritionally highest risk: those in the lowe income quartile among infants up to 3 years of age, ado cents 10-16 years, persons over 60, and pregnant or lac- tating females.

The data presented here are almost entirely from th nationwide surveys. Ten-State's contribution, as will b seen, is that because its information was the earliest o this sort to become available, it provided essential clu that were verified in the later surveys.

The sample sizes were 11,337 for Ten-State, 20,749 HANES I, and 28,030 for NFCS. The collective total for three surveys added up to 60,116 persons and, with the t additional days of NFCS, 116,176 person-days.

The more than 3,000 food items that were consumed b respondents in the surveys were assigned to 15 major foo groups as categorized by the developers of Ten-State. Th groups were primarily nutrition-related rather than produ oriented. For example, the Cereals and Grains category includes bread and rolls, crackers, hot and cold breakfas cereals, pancakes, and plain pasta, but not foods in whic farinaceous ingredients are important but not dominant, s as pizza or spaghetti with meatballs.

THE DATA'S RELIABILITY

If confidence is to be placed in the findings, it is first necessary to determine whether the data are reliabl The usual test of reliability, and indeed all that is de- manded in the case of small-scale studies, is whether the same method when repeated yields the same results.

Replicating a nationwide survey is obviously not feasible. However, in this instance an even more rigorou test of reliability was possible, since in NFCS the same were sought from the same respondents on sequential days two different methods, interview and diary.

Average gram consumption for the 15 food groups duri

each of the three days of NFCS are presented in Table 1. Despite the different methods, on the relative advantages and disadvantages of which there has been an extensive literature of debate (well summarized by Marr 1971), the per capita amounts remained quite stable. There was a tendency toward under-reporting by the diary method, whether due to forgetting or fatigue, yet the difference from day to day in total grams reported was only 2.7%.

Table 2, in which the gram amounts have been translated into shares of total diet, gives a fairer picture by removing the influence of data collection method. Here, for all practical purposes, reliability vanishes as a concern; the day-to-day differences are minuscule and, with rounding, would vanish entirely.

It may be concluded, then, that when compared with the other most feasible method, 24-hour interview recall emerges as a reliable means of gathering data of this type.

Reliability, of course, merely says that when a method adds two plus two it repeatedly comes up with the same answer, regardless of whether that answer is three, four, or five. Validity requires that the results be consonant with those from other sources. Because the present data are on consumption and most other extant information on food use is based on distribution or disappearance, meaningful comparisons are difficult. Within these limitations, the articles by Schwerin et al. previously cited deal with validity and conclude that it is present.

In other words, the surveys appear to have measured what they purported to measure, the kinds and amounts of food that people actually consume in the "real world".

WHAT PEOPLE ATE

To provide a general perspective, Table 3 capsulates the change in the nation's diet between the early and latter parts of the decade just past. The table compares average grams and calories ingested by the "common sample"; that is, it omits from the NFCS sample persons under one year of age or over 74 years old, the two groups that were not included in the HANES I sample. This comparison shows that Americans have on average begun to eat less food by volume, while at the same time they have been obtaining more calories from that somewhat smaller amount of food.

These averages, though, conceal the striking fact that older people were almost entirely responsible for the increase in calories. As can be seen from Table 4, up through the ages of 35 among women and 50 among men, caloric intake otherwise declined at virtually all levels.

The foods that were the vehicles carrying these calories are the subject of Table 5, which shows average gram con-

TABLE I

Grams Per Capita, NFCS

(n=28,030)

	Day 1 (Interview)	Day 2 (Diary)	Da (Di
Dairy products	325.2	328.8	31
Meats	98.1	93.0	9
Poultry	25.2	24.5	2
Shellfish	1.3	1.3	1
Fish	8.7	9.4	11
Eggs	23.4	21.8	23
Soups, sauces, gravies	45.5	47.6	46
Fats and oils	12.2	11.7	11
Legumes and nuts	18.5	17.8	17
Cereals and grains	132.4	129.8	132.
Vegetables and fruits	331.4	320.9	323.
Sugary foods and beverages	170.2	161.0	161.
Desserts	63.6	58.6	61.
Non-sugary beverages and condiments	407.6	394.2	389.
Mixed protein dishes	111.5	111.4	106.
	1774.8	1731.8	1727.

* Variation in grams from Day 1 = 2.7%

TABLE II

Percent Share of Total Grams, NFCS (n=28,030)

	Day 1 (Interview)	Day 2 (Diary)	Day 3 (Diary)
Dairy products	18.3%	19.0%	18.4%
Meats	5.5	5.4	5.6
Poultry	1.4	1.4	1.4
Shellfish	.1	.1	.1
Fish	.5	.6	.6
Eggs	1.3	1.3	1.3
Soups, sauces, gravies	2.6	2.7	2.7
Fats and oils	.7	.7	.7
Legumes and nuts	1.0	1.0	1.0
Cereals and grains	7.4	7.5	7.7
Vegetables and fruits	18.7	18.5	18.7
Sugary foods and beverages	9.6	9.2	9.4
Desserts	3.6	3.4	3.6
Non-sugary beverages and condiments	23.0	22.8	22.6
Mixed protein dishes	6.3	6.4	6.2
	100.0%	100.0%	100.0%

TABLE III

Total Calories and Grams
Per Capita Per Day,
Common Sample *

	HANES I (n=20,729)	NFCS (n=28,838)	% CHA
Calories	1828	1875	+ 2.6
Grams	1933	1794	- 7.2

* Excludes infants under 1 year old and adults over 74

TABLE IV

Calories Per Capita Per Day

for Sex and Age Subgroups

	HANES I		NFCS	
Age in Years	Calories	n	Calories	n
Male and Female				
1-2	1315	1123	1195	1125
3-5	1643	1772	1459	1840
6-8	1918	992	1780	1994
Male				
9-11	2228	531	2068	1016
12-14	2456	548	2364	1223
15-18	2863	640	2649	1493
19-22	2901	459	2470	728
23-34	2740	994	2480	1917
35-50	2444	1126	2349	1836
51-64	2073	901	2182	1526
65-74	1751	1646	1927	766
Female				
9-11	1937	534	1836	1096
12-14	1934	559	1891	1202
15-18	1760	629	1772	1547
19-22	1662	818	1607	850
23-34	1633	2263	1600	2441
35-50	1531	2155	1545	2539
51-64	1396	1005	1530	2210
65-74	1270	1813	1421	1188
Pregnant/ lactating	1742	221	1744	301

TABLE V

Grams Per Capita

Per Day, Common Sample *

	HANES I		NFCS	
	Grams	%	Grams	
Dairy Products	406	21.0	337	1
Meats	90	4.7	98	
Poultry	18	.9	25	
Shellfish	2	.1	2	
Fish	11	.6	9	
Eggs	26	1.3	24	1
Soups, sauces, gravies	42	2.2	51	2
Fats and oils	20	1.0	20	1
Legumes and nuts	21	1.1	17	
Cereals and grains	145	7.5	136	7
Vegetables and fruits	313	16.2	322	18
Sugary foods & beverages	228	11.8	185	10
Desserts	48	2.5	41	2
Non-sugary beverages and condiments	499	25.8	414	23
Mixed protein dishes	64	3.3	113	6
	1933	100.0	1794	100

* Excludes infants under 1 year old and adults over 74

TABLE VI

Grams of Cereal and Grain Products Per User Per Day For Sex and Age Subgroups

	HANES I		NFCS	
	Grams	n	Grams	n
Male and Female				
1-2	103	1097	104	1094
3-5	138	1747	125	1812
6-8	164	981	143	1966
Male				
9-11	183	529	159	996
12-14	196	532	181	1189
15-18	211	619	194	1434
19-22	192	437	178	679
23-34	186	953	172	1780
35-50	171	1091	167	1727
51-64	162	883	165	1454
65-74	165	1612	170	751
Female				
9-11	164	529	146	1066
12-14	147	548	145	1134
15-18	135	595	133	1420
19-22	125	776	127	749
23-34	121	2112	119	2161
35-50	115	2042	120	2290
51-64	113	971	121	2087
65-74	117	1772	124	1145
Pregnant/lactating	145	209	138	287

TABLE VII

Structure of Eating Patterns

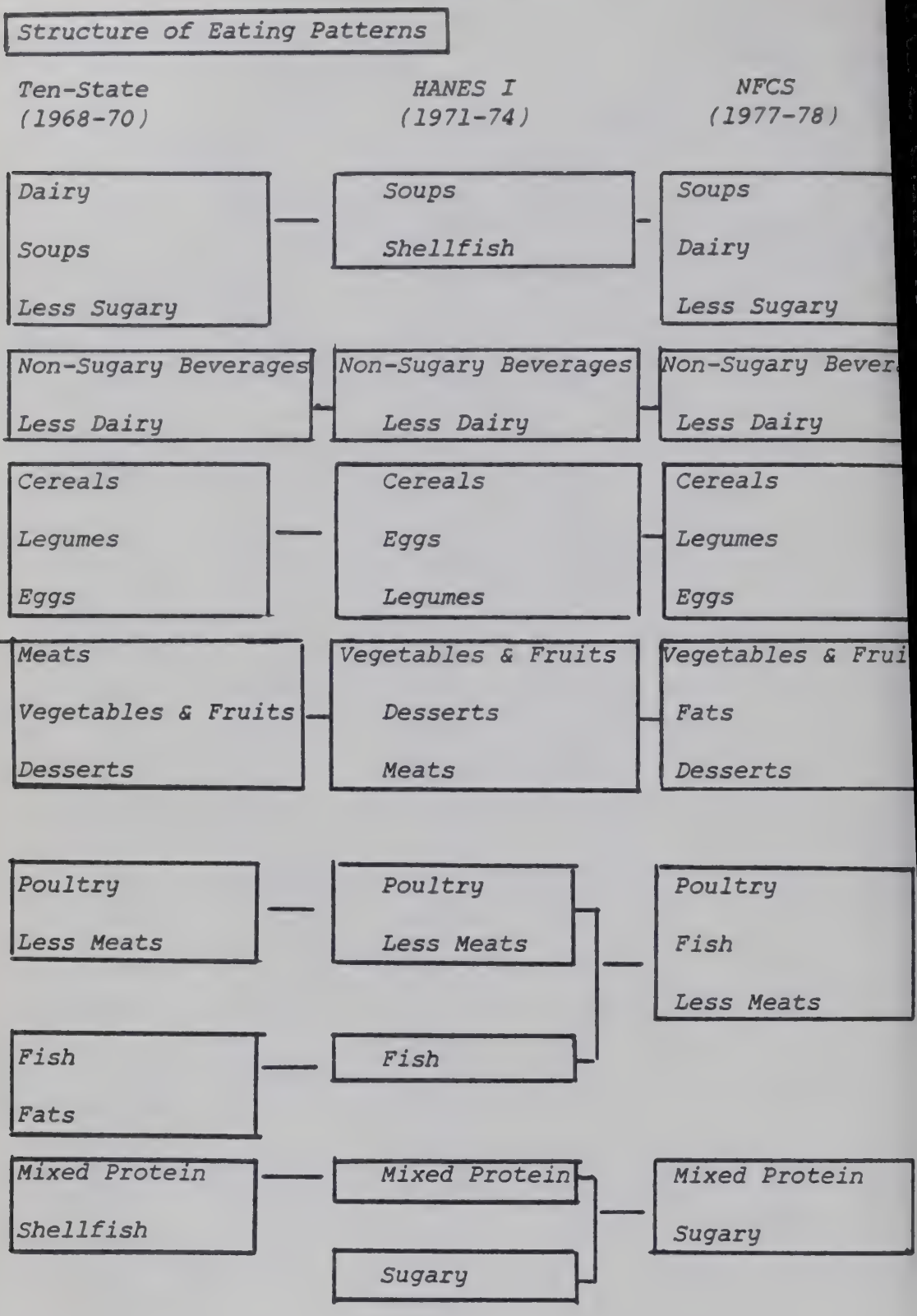


TABLE VIII

rcent of NFCS Total

mple in Each Pattern

	Day 1	Day 2	Day 3
Soups, Dairy - Less Sugary	15.6 (5)	15.5 (5)	15.7 (5)
Non-Sugary Beverages - Less Dairy	19.1 (1)	19.3 (1)	18.6 (1)
I Cereals, Legumes, Eggs	13.3 (6)	13.5 (6)	13.7 (6)
Vegetables and Fruits, Fats, Desserts	18.1 (2)	17.8 (2)	17.7 (2)
Poultry, Fish - Less Meats	16.7 (4)	16.7 (4)	17.1 (3.5)
I Mixed Protein, Sugary	17.3 (3)	17.3 (3)	17.1 (3.5)

= Rank

TABLE IX

Percent of Total Sample in Each Pattern

Eating Pattern Groups Per Ten-State Structure		HANES I		NFCS	
I	Dairy	15.6	(2)	16.0	(2)
	Soups				
	Less Sugary				
II	Non-Sugary Beverages	19.3	(1)	18.9	(1)
	Less Dairy				
III	Cereals	14.5	(4)	12.6	(6)
	Legumes				
	Eggs				
IV	Meats	15.2	(3)	15.5	(3)
	Vegetables and fruits				
	Desserts				
V	Poultry	14.4	(5)	14.5	(5)
	Less Meats				
VI	Mixed Protein	12.2	(6)	14.9	(4)
	Shellfish				
VII	Fish	8.8	(7)	7.6	(7)
	Fats				

(◯) = Rank

:ption for each of the 15 basic food groups. The most table upward changes were in consumption of mixed protein shes, poultry, vegetables and fruits, soups, sauces and avies, and meats. The main downward movement was in dairy oducts, non-sugary beverages (such as coffee, tea and diet inks) and foods that were primarily sugary. Cereal and ain foods was one of the categories in which there was ttle change.

Table 6 reveals that there was a gain in consumption of reals and grains among older segments of the population, as ainst losses among most other age groups. It is interesting speculate that educational efforts concerning the health nefits of bran may have played a role in this outcome.

THE PATTERNS OF EATING

Underlying the ups and downs of consumer usage of partilar foods is the fact that people tend to have various aracteristic diets, or eating patterns. That is, by prerence or necessity, they eat relatively more of certain ods and less of others, in definable combinations.

Starting with the food group gram consumption as input, factoring technique -- varimax rotated factor analysis with iser normalization -- was employed to discover these patrns, to which the respondents were assigned on the basis of e nearness of their individual factor scores. What emerged, erefore, was a segmentation of the sample population in rms of how their diets best clustered.

Table 7 is a schematic of the resulting patterns as realed in the three surveys. The descriptors identifying ch pattern are those food groups of which its membership nsumed disproportionately greater or smaller amounts at a gnificant level.

These patterns have remained remarkably stable from sur- to survey over the ten-year period. For example, the ttern that is characterized by above-average consumption of reals and grains, legumes and nuts, and eggs retained the ne descriptors throughout. Hence it is reasonable to conude that these two other food groups are most frequently sociated with cereal products in the habitual diets of a bstantial, definable segment of the population, a finding of portance in determining what nutrient addition is desirable.

Like the basic data, the patterns pass the test of reability. Table 8 gives the percentages of people assigned the six patterns of NFCS on each of the three days. These rcentages scarcely varied, evidencing that factor analysis oduces the same result regardless of the day or the data llection method chosen.

Over time, however, it appears that some patterns have en gaining adherents at the expense of others. In Table 9,

the eating patterns that were found in Ten-State have cessively been imposed on the other two surveys. The loss in membership occurred in the cereals/legumes/egg tern and the mixed protein pattern enjoyed the greatest with a resulting exchange in rankings. (The same sort shift in the relative size of these two patterns took p incidentally, when the HANES I and NFCS factor structur similarly imposed on both studies.

SUMMARY

The most reliable data available on the kinds and of food that are actually consumed by Americans indicat the overall per capita amount eaten has gone down slight but that caloric intake has risen. Consumption of the f food group made up of cereal and grain products has rema about level, an average that hides a gain among older pe and a loss among most of the rest of the population. Ho the eating pattern for which these products, together wi legumes and nuts and eggs, are descriptors has fallen of membership.

The larger implication for the cereal industry is t challenge it faces in adapting to these developing trend

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THE ROLE OF GRAIN-BASED FOODS IN DEVELOPING COUNTRIES

Morton I. Sosland

Milling and Baking News
Kansas City, Missouri 64112

Unlike many of the scientific topics on the agenda for is meeting, the subject assigned to me may properly be per- ived by many authorities in this audience as being quite scientific. Indeed, opinions and views on the role of ain-based foods in developing countries may be observed as anging quite swiftly over time, indeed from month-to-month d from year-to-year in response to the rapid pace of change the world's economic and political situation. Those of us o have had as much as a decade of experience in this bus- ess have already seen the full gamut of views, ranging from e opinion that the developing countries would be very poorly rved to develop a food system relying substantially on ain-based foods to those who contend, as I do, that such liance provides the safest, surest and most efficient means satisfying their peoples' striving for better diets than st now enjoy. I hope that the impact of that striving will kept firmly in your mind as perhaps the dominant influence, ong with production improvements, on the base question fore me.

My optimistic assessment of the role of grain-based foods ems primarily from my belief in the efficiency of the world ain trading system. It is a case built not just on the olution of that system over the centuries, but on how it s survived and even grown during the most difficult several cades in all history, that is the most recent period. In ew of my prejudiced position, I recognize that my conclusion at grain foods are now and will be, or should be, into the reseeable future the basic food for the developing world is declaration requiring both justification and explanation.

It's also important to acknowledge from the very start at any theory of the central role for grain-based foods is t writ in stone. Indeed, those of us who strongly believe, d even preach, the grain-based foods case -- and I suspect, would hope, that this is the position of almost all of us re in this room -- have a great deal of work to do. It's

my opinion that we still have before us the formidable
of convincing hundreds of governments and hundreds of m
of people of the merits of our case. Regretfully for u
history of the past decade or so has been such as to ch
at almost every turn our belief in the central role of
based foods.

The presentation of my case begins with a definitio
is that grain-based foods are those foods directly deriv
processed from cereals, as distinct from all other foods
especially those foods, like meat and chicken, which req
processing of grain through the digestive system of an a
In simplest terms, our case is that these grain-based fo
offer to both the developed and developing nations the
strongest possible foundation to assure their peoples of
adequate supply of low-cost and nutritious foods. For s
thousands of years up to the beginning of the decade of
1970's, that case was widely accepted by thoughtful obse
on the world food scene, no matter on what continent the
based and without regard for the standard of eating in a
ticular land or region. But beginning in the early 1970
a series of political and economic upheavals occurred, an
occurred, to the point where this historically-evolving p
tion is being increasingly called into question.

These questions, though, are not being raised on acc
of the main reason I suspect the subject you assigned to
on your agenda. The arrangers of this program probably w
seeking views on whether it makes any sense to consider m
of enhancing the nutritional quality of grain foods witho
also addressing whether it is likely that the basic, uneni
and unimproved grain foods supply into the foreseeable fut
will be sufficient to meet the basic needs of both develop
and developing countries. The question you ask is an impo
tant one, and it shall be addressed, along with the issues
that are of equal significance: How to cope with the radi
politicalization of trade in grain and how to foster econo
systems that will do the best job of assuring an adequate
supply of grain.

When it comes to supply adequacy -- the ability of th
world to raise enough foods to meet future needs -- I'm an
optimist if for no other reason than that the optimistic
assessment has been correct in reaction to every moment of
food trauma witnessed in the past several decades. Those
have forecast famine and widening malnutrition and hunger
far have been proved wrong, as evidenced by the quiet from
doomsayers' camp in the current situation marked by stock
buildups and worries about producer incomes. What has hap
pened, though, is that the moments of trauma, of shortages
and deep concerns, have increased in frequency. According
my count, we have had three "moments" (some of several yea

ration and others only a few months long) when the nay-
ers and the pessimists have carried the day in asserting
at the Reverend Thomas Malthus was correct in his late 18th
ntury forecast that growth in world population would at
me point outstrip the world's food production capacity.

It is important in the context of this presentation to
cite this litany of dire warnings if for no other reason
an my strong belief that similar occasions will strike with
creasing frequency in the future. What we need to do is to
ild a bulwark to guard against those moments undermining
e confidence that must exist, if the system is to work, in
e world's ability to supply enough food for its people, in
veloped and developing lands. For that reason, it is most
portant for policies to be shaped that, while recognizing
e certainty of repeated worldwide concerns about food hun-
r, also perceive that such moments have their own self-
rrecting systems that, with each event, thus far, have
ined increasing power.

Let me emphasize also that I do not advocate a strictly
llyannish view of the world food scene. This too should be
oided with the same fervor as the famine-predicters are met
th doubt. What I am saying, though, is that the recent
a marked by an increasing number of moments when the world
peared to be facing a severe food crisis actually have led
new and higher plateaus of production. The crises them-
lves obviously play an important role in stimulating grain
oduction. Parenthetically, this is much the way the market
self works, as reflected in the saying that "there's no
re for high prices like high prices," and, of course, vice
rsa. Or like the saying that at a certain price even the
osters will lay eggs.

It is instructive to recall these moments of food crisis
om the immediate past. The first of these worldwide food
ergencies struck at the middle of the 1960's. It had a
ticularly devastating psychological impact since it came
er nearly two decades during which world food policy was
ost entirely formed by the need to dispose of surpluses.
rplus disposal policy" was the order of the day in many of
e global institutions that now wring their hands about an
equate food supply. Precipitating this shattering of a
ld where it had been commonplace to believe that the food
oblem was one of excess were India's huge and unprecedented
eat import requirements, precipitated by a series of monsoon
ilures. World stocks of food grains were drawn down so
pidly that a lot of pessimists gained quick standing by
claring that the world food apocalypse was upon us in full
rce. After all, you can hardly blame these people whose
ely voices of warning about the world running out of food
e hardly heard during the time of the surpluses of the

1950's and early 1960's.

The second moment of distress, occurring at a con
ably higher supply and production plateau than the firs
triggered in 1972-73 by the Soviet Union buying from th
more grain than any country had ever bought from anothe
all of history up to that time. Parenthetically, it sh
be noted that in more recent years, including this curr
crop season when grain prices have been characterized b
siderable weakness, the U.S.S.R. has bought much more w
and other grains from the U.S. and other countries than
1972-73 when many people were absolutely certain the wo
food system was failing and there would no longer be en
to go around. Sharply rising U.S. prices and falling s
led to predictions of shortages, world hunger and malnu
That memorable year of 1972-73 was followed by 1973-74
1974-75, which saw China's entry into the world grain ma
heavy demands from other nations fearful they would be u
to cover their requirements on the world market because
the dimensions of the U.S.S.R. and China buying, and aga
predictions of calamitous shortages, escalating malnutri
and even starvation.

The third time of these alarms being raised occurre
only a little more than a year ago, in late 1980 and int
early 1981. Weather conditions for the 1981 crop were n
very favorable in many areas at that time, the U.S.S.R.
scouring the world for grains and even grain products as
result of the export sales embargo imposed early in the
by President Carter, and doomsayers cautioned that the n
elected President, Ronald Reagan, should go very slow in
living up to his campaign assurances that he would end th
embargo on U.S. grain exports. It was their contention,
silly as it may have turned out to be in the light of wha
has happened, that world supplies might be inadequate to
requirements in the event the full force of Soviet Union
buying, then restrained by the embargo, was turned loose
the American market. These dire warnings were rendered
before anyone knew, or even imagined, that the U.S.S.R. a
in 1981 would fall short on its crop production targets.
one at that time was brash enough to predict that the Sov
Union could experience three consecutive years of disastr
small crops, sharply depleting its stocks and making cert
of that country's presence on the world market as a buyer
every bushel of grain it could handle through its ports a
inland transportation system.

And three times American Presidents reacted to the w
grain situation then existing in ways that in my judgment
have caused many importing countries to wonder about buil
a food system reliant on grain. On two occasions, first
President Nixon and then President Ford actually limited

ports of grains from the U.S. in response to warnings from within their inner circles -- but contrary to the recommendations of their Secretary of Agriculture. It is instructive to note that these limitations were primarily designed to protect the domestic U.S. economy from the perceived inflationary impact of unrestrained grain exports. It was only after exports were limited for domestic economic reasons in the Ford years that foreign affairs issues suddenly were also raised, leading to the negotiation of the original five-year U.S. - U.S.S.R. grain sales agreement. And even though politics were involved, the main purpose of that agreement, it should be recalled, was to protect the domestic U.S. market from "surprise" buying by Moscow.

At no time did the initiatives in limiting grain exports by Presidents Nixon and Ford reflect other than very self-centered domestic considerations. Politics aside, history will very likely adjudge both of those actions as being indifferent to the realities of the world scene and also unsuccessful in achieving the purposes for which they were intended. Indeed, the final fate of both those Presidents is ascribed in part to their actions to limit grain exports, which stirred the ire of an important constituency. And getting a little bit ahead of myself, the grain embargo certainly turned out to be an election negative in November 1980 for Jimmy Carter.

Even though domestic issues dominated, the Nixon and Ford actions did set the groundwork for the ultimate restraint on grain exports -- President Carter's export embargo imposed on shipments to the U.S.S.R. on January 4, 1980, in reaction to that country's invasion of Afghanistan. This is not the forum to discuss the political, economic or even military pros and cons of that controversial undertaking. It is the place to say, though, that the embargo did not work; that in the eyes of most nations around the world, the U.S. was both naive and untrustworthy to think it could halt the flow of grain to the U.S.S.R. or that it could unilaterally cut across purchase contracts.

And this move by President Carter, even though criticized by Candidate Reagan during the 1980 campaign as unfair to U.S. farmers because it singled out grain as the embargo's main target, is still very central as an influence on the present-day world grain market. Much of the weakness in grain prices late in 1981 and thus far in 1982 could be directly ascribed to concerns that Mr. Reagan would again move to restrict grain exports, as part of a more broadly conceived embargo on shipments to Eastern Bloc nations, in response to the very troublesome situation in Poland. A fascinating insight is that a number of other countries, both developed and developing, have factored in this possibility

in both their grain purchasing and in their grain supply strategies. In years past, a war-threatening situation the imposition of martial law and the massing of Soviet troops on Poland's borders would have caused a flurry of buying as nations sought to build up their stocks ahead threatened catastrophic conflagration. This time, thoug have seen those importing nations hang back in their purc confident that the U.S. would embargo shipments to the S Union and thus assure them of a plentiful supply at reduc prices. And, of course, those countries have been quite right in their purchasing assessments thus far.

When the Soviet Union in the summer of 1972 bought a that grain from the U.S., we pointed out on numerous occa that Moscow's undertaking served as a signal that flashed around the world. That signal said something like this: the most repressive police state the world has ever known finds it necessary to spend billions of dollars to purcha grain to maintain the food supplies of its people in orde forestall unrest, then every other country, almost withou regard for its resources, will certainly find it necessar devote an increasing amount of attention to the adequacy its food supply. Developments since 1972 largely affirm this has been the case, that many governments in the past decade have taken actions to improve their food supply sit tion. This trend has been observed in practically every r area of the world, and, indeed, in most countries. Gains standards of living in most nations for the past decade or have largely taken the form of improvements in the standar of eating. Improvements in personal income levels have be reflected in better diets, which for many nations means mo and better bread.

Of course, these dietary gains have not been uniform, either by countries or by sectors of the populations, and case can be made that some millions of people still have d that may be judged inadequate by any number of standards. Yet, I'm also impressed by recent work showing that estima of food shortages and hunger have been exaggerated. Wheth the estimates of hunger have been "grossly overstated," as Professor Thomas T. Poleman of New York State College of Agriculture recently concluded, is something best to be avoided in our context today. I cannot help but observe, though, that Professor Poleman's finding that "understatem of production is a characteristic of most newly-developed agricultural reporting systems" provides some helpful in- sights into a few of the seemingly inexplicable difference between expected demand and actual purchases of recent yea on the part of quite a few nations. Also fascinating is h further theory that "compounding the tendency to undercoun food availabilities have been the difficulties associated

estimating food needs."

But let me note that the numbers on world grain consumption, both the aggregate figures and most of the individual country figures, would indicate that for most of the past decade, disappearance of grain increased at a faster rate than population grew. Most significant in the context of this paper, which places major emphasis on the importance of trade in grain to achieving food supply adequacy, is that world trade in wheat and coarse grains this year is accounting for 18 per cent of total disappearance, compared with only 11 per cent at the start of the 1970's and just 9 per cent in 1960-61. That 18 per cent share is a new record high, reflecting the rising importance of trade.

One problem, though, is that consumption numbers, whether applied on a country, regional or global basis, are averages, and averages are subject to justifiable attack in the context of judging food supplies. It is very apparent that a widening chasm has developed in the statistics used by those who contend, on the one extreme, that more than 500 million people in the developing world are undernourished, and those who hold that the actual number is less than that. I much prefer the viewpoint that all of our diets could stand improvement, and that grain-based foods offer the best way of achieving this, either in developed or developing countries; in those countries where concerns about health focus on obesity, and also in those lands where simple observation of individuals leads to the certain conclusion that the people are not eating well.

Having questioned the value or meaning of global numbers, I must return to one set of figures that is basic to an understanding of how developing countries may best proceed to build a system that will assure an adequate supply of grain-based foods. In my judgment, the most sensible approach rests on the concept of self-reliance as compared with the traditional goal of self-sufficiency. The latter is defined as growing enough crops domestically to satisfy all prospective needs; the former means aiming for a balance between domestic production and reliance on the world market as a supply source. Many of the countries that have done the best job of moving from a less-developed to a developed status are those which have embraced this concept of self-reliance as distinct from single-minded focus on increasing domestic production regardless of cost. These countries, it should be observed, have utilized the availability of grain moving in world trade as a kind of supply safety valve. They have been comfortable in allowing or even encouraging an increase in their domestic standard of eating, all the while being assured that if domestic crops should fail, for any number of natural reasons beyond control, that they could fall back on

world trade availabilities to protect basic consumption levels.

Several elements are essential to the successful wo of this self-reliance approach. One is recognition that a program works well only in countries where there is at least a semblance of a functioning marketplace. Without price mechanism to encourage an increase in consumption prices fall and a reduction in consumption when prices r self-reliance is much less likely to work. The alternat bureaucratic administration, has so many built-in ineffi- ciencies and inequities that even the most vociferous cr of the market as a means of allocating food supplies woul have to take a second look when making comparisons betwee the two approaches. It is the market, it may be observed that encourages attention to the quality of foods. It is market that encourages an improvement in the quality of t supply as distinct from those examples where a bureaucrac focuses on everything but human desires, making food deci without regard for quality considerations.

It is particularly important that nations aiming for self-reliance should place their livestock and poultry pr duction systems on a price-responsive basis; that is, resp sive to the effect of price on rates of feeding. One of great causes of stress in the world food system is that so few nations, other than the U.S., make their feeding econo responsive to prices. In years when the world grain crop less than disappearance -- most often the years of stress prices and politics -- the livestock feeding industry in t U.S. has been called upon to serve as almost the only buff against rapid shifts in world grain availabilities. Just it is simply not acceptable for the Kremlin to brag that bread prices in the Soviet Union have not changed since 19 thus proving that the Communist agricultural/food system works, it is impossible for the world to sustain large liv stock and poultry numbers that are unresponsive in their feeding rates to market forces. Once these market forces allowed to come into play, as they must, then it's my opin that the age-old, but really meritless, debate on the effi ciencies and values of grain-based foods versus fed livest and poultry will disappear. Let me observe that I have no doubt but that those of us who favor grain-based foods wou gain the upper hand in this confrontation.

Of course, that outcome also depends on how the rest the world regards the political and economic jockeying, or playing, with grain supplies that has become a hallmark of U.S. foreign policy. Making use of grain as a political, economic or even semi-military weapon very obviously has b come one of the cornerstones of White House policy, regard less of the party or the political persuasions of the occu

grant. Three U.S. grain embargoes and a threatened fourth, which is the period we are currently experiencing, very obviously have exerted major effect on buying policies of grain-importing nations. Of course, that effect goes well beyond the short-term result of providing a favorable buying opportunity, as noted before. Indeed, it can be sensed that America's willingness to use and to threaten restrictions on grain exports has resulted in other countries re-thinking their grain policies. Yes, and some have begun to wonder about the merits of self-reliance, when that approach means dependence on grains from the U.S.

A number of developments signify this change of heart. One of the most striking was a recent statement by the Minister of Agriculture, Fisheries and Food of Great Britain, the nation that has practiced self-reliance, as distinct from self-sufficiency, for so many years. Peter Walker, the minister, recently declared his belief in the agricultural policy of the European Community, which is self-sufficiency rather than self-reliance. Of course, Britain is a member of the Community. Mr. Walker said, "To contemplate relying more and more on uncertain world food markets to feed the Community's 260 million people -- and one cannot ignore another 50 per cent rise in the world population by the turn of the century -- is not an option governments can entertain."

Then there's Japan, which in the post-World War II years seized the concept of self-reliance to its great economic advantage. Suddenly in the last couple of years Japan has sought to restrain growth and even to moderate or cut back consumption of wheat foods in favor of rice. Self-sufficiency in rice production had simply gotten out of hand, to the point where a huge surplus of that crop is being used as an excuse to reverse that country's growth as a wheat foods market.

Let's look at several developing lands. One is Indonesia, a country that is straining to move from developing to developed status and which has the natural resources to achieve that end, particularly with its large reserves of oil and gas. Indonesia has been a sizable importer of both rice and wheat, but the uncertainties of the world scene have given its government new incentives to strive for self-sufficiency. This has led to a multibillion-dollar effort to become self-sufficient in sugar production. It now is expected that similar efforts will be launched to encourage increased production of other domestic crops like cassava and sago. Technicians have been set to work to develop foods acceptable to Indonesians that may be made from these crops, thus wooing consumers away from their long-standing preference for rice and wheat flour products.

Still another developing example is our neighbor to the South, Mexico, which in the wake of President Carter's

embargo action, officially enunciated a plan of achievin self-sufficiency in food "at any cost." The prospect is Mexico is rapidly approaching that point, causing the lo an important U.S. export market and structuring its dome economy in a way that makes little sense from the viewpo of improving the country's economy or the level of diet.

Some of these latter trends also have recently appea in Nigeria, another developing nation with vast natural r sources that promised to become a great consumer of grain based foods. In response to world political conditions a even to speculation of whether the U.S. would cut off gra supplies if Lagos did something the American government d not like, attention is being given to encouraging increas consumption of so-called native foods.

I note from your agenda that this workshop was not c to discuss the means of adding nutrients to yam bread or cassava cake. And I'm not stating that that is a serious omission. I do say, though, that our mutual goal of achi an adequate supply of food for the peoples of the world, b on grain, has no automatic mechanism to assure acceptance. Nutrient improvement is one way, and you are focusing on t Success, though, also requires a greater constancy of supp than the U.S. has been willing or able to reflect in its e port policies of recent years. Somehow and in some way th nation must find the drive to develop an export policy for grains that precludes the kind of political jockeying and threats that obviously serve little or no foreign policy purpose and are a disservice to the nation's grain farmers and to the U.S. domestic economy.

Let me conclude by noting that I have more confidence your ability to enhance the nutritional value of grain-base foods than in the ability of governments to fashion the ki of grain system that will best serve mankind's future. Ye for you to succeed, such a system is absolutely essential. Otherwise, our global future will be much less bright than might have been.

NUTRITIONAL ASSESSMENT AND FOOD FORTIFICATION

Irwin Hornstein, Ph.D.

Department of Agricultural and Chemical Engineering
Colorado State University
Fort Collins, Colorado 80523

AACC WORKSHOP
"Adding Nutrients to Foods - Where Do We Go From Here"

I will discuss Nutritional Status Assessments in the Less Developed Countries (LDCs) and their relationship to the broader topic of factors to be considered in recommending and implementing fortification programs in the LDCs.

Ideally, a nutrition survey should be instituted as part of a larger commitment by an LDC government to improve the nutritional status of the population, without this commitment a survey is a rather sterile exercise. A survey will reveal the nature, magnitude and geographic distribution of nutrient deficiencies. If one or more of these deficiencies are considered a public health problem, there may be a place for a follow-up fortification program. A fortification program that is ill-conceived, and/or poorly designed will be wasteful of resources, bereft of benefits, and a deterrent to the introduction of needed fortification programs elsewhere in the developing world. It is therefore imperative that prior to recommending a fortification program, information should be obtained concerning the causes of the nutrient deficiency, the cultural, economic, and logistic barriers that must be overcome in order to implement a program, the real costs of fortification, and the potential benefits of the program.

The first major assessment of nutritional status in LDCs utilizing standardized procedures was made by the Interdepartmental Committee on Nutrition for National Defense (ICNND). These surveys were implemeted in 33 countries during the period 1956-67. They began in response to requests from Iran and Pakistan for help in evaluating the nutritional needs of

their military personnel. Once initiated, these surveys were broadened to look at all segments of society. Clin biochemical, and anthropometric measurements provided a line measure of Nutrition Status. The ICNND Manual for carrying out these surveys has been published (ICNND 196 Table 1 summarizes the nutritional problems identified i those surveys conducted during the years 1960-67. Altho there has been considerable economic progress in some of these countries, these nutritional profiles are generall still considered valid.

Table 1. Prevalence of Nutrition Problems in Selected Co tries, as Determined by ICNND Surveys

Country	Calorie protein deficit	Goiter	Anemia	Vitamin Deficiency			
				Ribo-flavin	A	C	Thiam
LATIN AMER.							
Chile	B	-	B	-	35	18	-
Colombia	B	47	B	-	-	22	B
Bolivia	B	B	B	A	B	B	B
Uruguay	-	13	-	-	25	25	-
Venezuela	-	13	A	22	5	-	25
N.E. Brazil	A	23	35	10	40	11	25
Guatemala	B	5	9	34	A	-	-
El Salvador	B	48	12	25	A	-	-
Honduras	B	16	16	13	A	-	-
Nicaragua	B	32	10	10	A	-	-
Costa Rica	B	18	9	16	A	-	-
Panama	B	16	16	42	A	-	-
AFRICA							
Nigeria	B	B	A	A	-	-	A
NEAR EAST							
Jordan	B	B	-	A	A	B	-
FAR EAST							
East Pakistan	A	25	A	A	A	A	-
Thailand	B	A	A	A	A	-	A
Burma	B	A	32	A	-	-	A
Malaya	B	A	B	B	B	-	B

Numbers = percent of population with low or deficient levels, as determined by biochemical analyses.
A = high incidence (over 10%) in the general population
B = high incident (over 10%) in special population groups or certain areas.
Adapted from McKigney, J. (1974).

Multiple nutrient deficiencies are the rule. In addition to protein/calorie malnutrition (PCM), iron, vitamin A, riboflavin and iodine appear to be uniformly low. One is tempted to generalize that in countries where food intake is low, not only do we have PCM and growth retardation but concurrent mineral and vitamin deficiencies. A second round of ICNND type surveys have not been carried out in the LDCs. However, surveys based on anthropometric measurements and hemoglobin have been made in a number of countries.

The Agency for International Development (AID) has been supporting nutritional status assessments in children below the age of six. (Preschool children provide a more sensitive indicator of nutritional status than adults. The nutritional status of preschool children is an index to the nutritional status of the population as a whole). Height for age, weight for age, and hemoglobin are the key measurements. An assessment of the methodology has been made. (NAS, 1979). Thus far the assessments have shown the percentage of children with low hemoglobin exceeds the number of children suffering from retarded growth. The data are summarized in Table 2. If PCM is the major nutrition problem in the LDCs, iron deficiency may be the most prevalent problem.

Table 2. Prevalence of Wasting, Stunting and Low Hemoglobin by Country

Country	%Normal anthropometrics	%Stunting only 1/	%Wasting only 2/	%Stunting and wasting	% Low hemoglobin 3/
epal	46.5	46.0	3.4	4.1	24.3
ri Lanka	62.4	29.8	3.8	4.0	NA
ogo	80.7	17.2	1.5	0.6	55.5
iberia	79.3	19.2	.8	.7	62.1
esotho	76.7	22.4	.7	.2	25.5
ierra Leone	74.9	29.2	3.0	1.1	
ameroon	79.9	22.1	1.0		38.1
gypt	78.6	20.8	0.3	0.3	38.4
laiti	70.4	23.6	2.9	3.1	33.0

1/ Less than 90% of reference median height-for-age.
2/ Less than 80% of reference median weight-for-height
3/ Under 2 years of age: hemoglobin concentration of 1 than 10 g/100 ml. Over 2 years of age: hemoglobin centration of less than 11 g/100 ml.
Unpublished Communication. Office of Nutrition, Agenc International Development, Washington, D.C.

Nutritional status surveys should be geared to the needs and resources of the host country. Surveys are e sive and expenses rise as complexity increases. Thus t insure logistic and financial responsibility, recent LI surveys have been relatively simple, rapid, and limited scope. For example, the AID surveys depend on anthropo ric measurements, hemoglobin determinations, a qualitat estimate of dietary patterns and weaning habits and a limited number of questions aimed at ascertaining socio economic status. The actual costs of several AID spons surveys are given in Table 3. There is considerable va tion in cost depending on terrain, ease of access to vi and households, and distance between households. For example, in Nepal access to many villages require the u helicopters; in Sri Lanka good roads and clustered house holds made accsss simple; while in Lesotho the terrain rugged, roads poor and households scattered. The unit household costs reflect those differences.

Table 3. Cost of AID Sponsored Nutritional Status Surve

Country	Popula-tion (mil.)	Area Sq. Km.	House-holds Sur-veyed	Cost U.S. Dollar Per house-hold	Per capita	Tota
Haiti	5.7	28,000	4,656	40	.034	190,0
Sri Lanka	14.5	65,600	4,947	34	.011	164,0
Nepal	5.8	142,000	6,578	27	.031	178,0
Liberia	1.7	111,000	3,987	39	.090	156,0
Lesotho	1.1	30,000	2,006	111	.198	223,0
Sierra Leone	3.3	72,000	5,243	35	.056	185,0

Unpublished Communication: Office of Nutrition, Agency f International Development, Washington, D.C.

The basic survey format can be expanded if the need exists. Thus, if a pre-survey examination of clinical d from hospitals and health centers indicates that signs o vitamin A deficiency such as Bitot spots and corneal sca

are fairly common, then a determination of the prevalence of vitamin A deficiency can be included in the survey. Clinical evidence of goiter might lead to the inclusion of a subset of individuals to be examined for signs of iodine deficiency, etc.

Once a decision is reached regarding the scope of the survey, successful implementation will require that:

1. The sample size and method of sample selection are statistically valid.

2. The logistic and financial resources are adequate.

3. Local institutions are involved and local personnel are well trained prior to the start of the survey.

4. The survey be implemented during a time of seasonal food scarcity rather than seasonal abundance. (If possible a survey during both seasons would be useful).

5. Clinical, anthropometric and biochemical measurement are standardized.

6. Adequate provision is made for data processing and data analysis.

Nutritional status surveys in LDCs have generally been under the guidance of outside experts, with varying degrees of participation by local institutions and local personnel. The AID surveys have given host country personnel a major role, for example, the survey co-director is from the host country. As a result these surveys leave an LDC capability that can independently implement subsequent surveys. The initial survey indicates where problems exist and provides a baseline for assessing progress in combatting malnutrition. If interventions are implemented subsequent surveys, not necessarily as thorough as the initial survey, (e.g. one may resurvey areas where deficiencies were most prevalent) can serve to measure the impact of these interventions in combatting malnutrition.

In summary, a well designed and well executed survey will provide information concerning:

1. The nutrient deficiencies that are prevalent in the country.

2. The severity and distribution of the deficiency.

3. The groups in terms of age, sex, income, etc. w malnourished.

4. The possible causes of the nutrient deficiency.

It is this last item--the possible causes of the deficiency that are most difficult to ascertain and are important in identifying the appropriate intervention o interventions. The relatively rapid and inexpensive su such as the AID surveys can identify and locate the maj nutritional problems of PCM and anemia, and by document dietary intake and dietary eating patterns provide some insight concerning the causes of these problems and the possible existence of other nutritional deficiencies.

Dietary surveys will also indicate which foods are eaten in sufficient quantity to be candidates for forti tion. Here too, considerations of cost, time, and train manpower availability have led to the introduction of qu tative rather than quantitative approaches. Obviously, quantitative data cannot be transformed into quantitativ conclusions but some assumptions may be warranted. For example:

1. In infants, a diet of breast milk only for a chil 4-6 months of age and older is likely to be asso- ciated with anemia since milk is low in iron.

2. If consumption of fruits and vegetables is seasona intake of vitamins A and C are likely to be low during the periods of non-availability.

3. A diet low in fat is probably calorie deficient, a

4. A relatively monotonous diet based on one or two f staples is a likely cause of mineral and vitamin deficiencies.

How might this work out in practice? Let us assume that in a sub-Saharan LDC a presurvey perusal of hospital cases and other available data indicated a high probabili of vitamin A deficiency. A subsequent nutritional status survey included both clinical and biochemical assessments vitamin A status and confirmed the existence of the defi- ciency with a relatively high prevalence in children. Th dietary intake patterns indicated that rice, which is neither a source of vitamin A nor of its precursors, was t basic food staple and the diet was relatively monotonous.

Green leafy vegetables and/or red palm oil which do contain vitamin A precursors were available but were not part of the normal food consumption pattern. To alleviate this deficiency, several approaches may then be feasible:

1. An educational campaign to convey to homemakers the importance of eating green leafy vegetables and using red palm oil in cooking.

2. A campaign to promote home gardens.

3. A massive dose campaign designed to supply, e.g. at 6 month intervals, vitamin A capsules to children under the age of six.

4. A fortification program to fortify a commonly consumed food with vitamin A.

5. A combination of two or more of these approaches.

To choose among these alternatives is the nutrition planners challenge.

Table 4 provides an intervention profile in terms of relative costs, impact, personnel requirements and community involvement for each of the four suggested vitamin A interventions--oral dose, fortification, home gardens, and nutrition education.

. Massive oral doses promise quick results at low ingredient cost to the target group. But they require considerable manpower and a well organized health distribution system and they also require the capacity to have broad coverage and regular contact with the target group.

. Fortification may take longer to produce results. Personnel requirements are low and permanence of benefits is high--as long as fortification is continued and the distribution system reaches those of risk.

. Nutrition education and home gardens may have more of a long range benefit. If the lessons are well learned these approaches in the long run, represent the most basic method for alleviating vitamin A deficiency.

The nutrition goals of the country and available resources will play a key role in selecting among these interventions. The selection will also be influenced by the severity of other health problems, existing or proposed country develop-

Table 4. Comparison of Alternate Interventions

Criteria	Forti-fica-tion	Oral Dose	Nutri-tion Educa-tion	Ga
Costs				
Initial investment	medium	low	low	me
Continuing personnel	low	high	high	lo
Continuing materials	low 1/	low	low	me
Personnel Requirements				
Skill level	medium	medium	low	me
Numbers	low	high	medium	hi
Administrative Requirements				
Supervision	medium	high	medium	me
Health system organization	low	high	medium	lo
Technical Feasibility				
Technology dependability	high	high	medium	hig
Side-effects risk	low	medium	low	lo
Acceptability	high	medium	medium	med
Community Involvement	low	medium	high	hig
Impact				
Population coverage	high	medium	medium	med
Time needed to show benefit	medium	low	medium	lo
Permanency of benefit	high	low	medium	hig

1/ An exception is protein fortification, which is expens
relative to micronutrient fortification.
Adapted from Austin, J. et al (1981).

ment programs, available funding sources, the ministries
institutions that will implement the program, personal
experiences and biases of key decision makers, etc.

A point often overlooked in proposing a program is t
need to educate policy makers concerning the importance
the nutritional problem to be solved. At the November 19

meeting in Nairobi of the International Vitamin A Consultative Group (IVACG), (this group meets annually and includes participants from UN agencies, other donors, industry and academia), the representatives from the African States of Ethiopia, Ghana, Kenya, Mali, Malawi, Nigeria, Senegal, Sudan, Tanzania, and Zambia jointly recommended that programs be initiated in their respective countries to eliminate vitamin A deficiency. Their recommendation asked for a set of interventions along the lines I have discussed. It is of interest that their first recommendation touched on the need for educating policy makers. "Decision and policy makers should be made aware of the importance of vitamin A deficiency and its consequences. It should be borne in mind that the commitment of resources to the control of vitamin A deficiency in the presence of more serious health priorities and the limitation of resources by most African Governments will be a major obstacle. The formula for presentation of the problem must be convincing and must be based on good information of local conditions".

What is true for vitamin A is true for any other program aimed at alleviating nutrient deficiencies. It cannot be over-emphasized that no matter how apparent the need to the nutritionist or food scientist, the decision to move ahead with a nutrition intervention will depend both on winning the hearts and minds of the policy makers and on delineating the peripheral as well as nutritional benefits that may derive from these programs.

A case in point. I have not discussed protein or amino acid fortification but in LDCs where protein deficiency is a reality, protein "fortification" of the basic food staple can be a useful intervention. In this particular LDC wheat is a basic food and essentially all the wheat is imported thereby presenting a considerable drain on needed foreign exchange. Therefore minimizing wheat imports is a major goal of the country.

This same country has been interested in becoming self-sufficient in edible oils and to that purpose has been encouraging soybean production. For soybean production to be economically feasible a market must be found for the defatted soy cake as well as the oil. It was logical therefore, for the country to consider adding defatted soyflour to wheat flour.

In this instance a triple benefit is achieved by fortifying wheat flour with soymeal at e.g. the 5-10% level.

(a) The nutritional need for added protein to the d is met.

(b) There is a saving in foreign exchange since les wheat flour is used to produce the same volume bread.

(c) Soy production is encouraged since a market has found for soymeal as well as for the oil.

I have over simplified this story but the lesson is clear. A nutrition intervention has been made more pala by demonstrating plural benefits.

If in some real life LDC situation a convincing cas made for a fortification program then a new set of issue actions must be considered. The following criteria for fortifying cereals, grains, and other food staples were reiterated by the Food and Nutrition Board of the Nation Academy of Sciences (NAS) in a 1974 policy statement. (NAS 1974).

"1. The intake of the nutrient is below the desireab level in the diets of a significant number of pe

2. The food used to supply the nutrient is likely t consumed in quantities that will make a significa contribution to the diet of the population in nee

3. The addition of the nutrient is not likely to cre an imbalance of essential nutrients.

4. The nutrient added is stable under proper conditi of storage and use.

5. The nutrient is physiologically available from th food.

6. There is a reasonable assurance against excessive intake to a level of toxicity."

Although these guidelines are equally applicable in developed as well as developing countries, the implementa concerns can be different particularly with respect to required "government actions".

I will conclude my remarks by summarizing some of th required actions.

. New legislation may be required or existing laws may require modification. Some rather unexpected roadblocks or situations can arise. For example, in countries where materials added to the food staple are considered adulterant special legislation may be needed to provide for adding fortificants.

. Provisions for monitoring and enforcing the new standards must be established. This in turn may require training of personnel. Who bears the cost of the training must be decided.

. Decisions must be made concerning the purchase of feeders and other equipment needed for fortifying, for example, cereal grains. Will these capital investments be made by the government or the miller?

. Decisions must be made concerning the import of vitamins and minerals. These decisions may involve foreign exchange considerations. If import taxes exist, legislation to allow fortificants to be imported tax free may be needed.

. And perhaps, most important, decisions must be made concerning who pay for fortification--the government, the processor, or the consumer. If the consumer pays then the most vulnerable group--the poor--may be harmed rather than helped.

To institute a fortification program can be a lengthy and sometimes frustrating experience. But fortification programs have been instituted in the LDCs and their favorable impact has been documented, particularly in cases involving vitamin A deficiency and goiter. AACC encouragement of fortification programs in the LDCs and the expertise of its members could contribute to the timely and effective resolution of many of the problems that inevitably arise during the structuring of a fortification program.

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TECHNICAL FEASIBILITY - EFFECT ON PRODUCT

James L. Vetter, Ph.D.
Vice President - Technical

American Institute of Baking
1213 Bakers Way
Manhattan, KS 66502

INTRODUCTION

The addition of one or more nutrients to foods has one primary purpose: to help improve the health and well-being of consumers of that food. Therefore, it is of paramount importance that nutrients which are added to foods 1) are present at the expected levels at the time of consumption, 2) the nutrients are biologically available, 3) and the foods are consumed at normal or predicted frequency. It is also important that the addition of nutrients during food processing does not alter the process or finished product characteristics in a way to increase costs unreasonably or reduce consumer acceptance.

We are concerned here primarily with the addition of nutrients to cereal products. Dr. Lachance has explained very well the important role that cereal products play in providing nutrients in the diets of American consumers. One reason for this contribution of cereal products to nutrient intake is the broad and frequent use of these products in the diets of all Americans regardless of virtually all demographic factors. Any change in product characteristics that would affect consumption patterns poses an economic hazard to a large industry and the threat of reduced total nutrient intake due to reduced consumption of the products of this industry.

Therefore, extreme caution must be exercised in changing current nutrient addition practices. Technical feasibility studies must be an essential first step in assessing any proposed changes in nutrient additions to cereal foods.

This is not to be interpreted as a negative or "resistan to change" attitude on the part of the processed cereal industry. Over the years, this industry has demonstrate its interest in - and commitment to - improving the nutr tional quality of its products for the benefit of consum This industry was a supporter of enrichment in the 1940s and rapidly moved - voluntarily - to the enrichment of bakery products when standards of identity were proposed and finalized in the 1950s. It was the milling and baki industries that filed the petition for higher iron level in bread and flour and vigorously fought the losing batt for FDA approval in the 1970s. It was these same indust that moved to evaluate the technical feasibility of impl menting the 1974 recommendations of the National Academy Sciences for the expanded fortification of cereal produc

The cereal industry will continue to support improvement in the nutritional quality of its products as long as th feasibility of these changes can be demonstrated. And policy makers, regulators, consumer advocacy groups and others must understand that changes in products cannot be made indiscriminately or without careful consideration of consequences.

It is obvious from what we have heard from other speakers at this Workshop, that technical feasibility is as important on the international scene as it is here domestically Just because the population of a country demonstrates a need for one or more nutrients, does not mean that these nutrients can be added to selected foods without first testing and confirming that the addition is feasible and that the products will be consumed as expected.

FACTORS IN TECHNICAL FEASIBILITY EVALUATION

Technical feasibility evaluations should include the following:

1. Can the nutrient be added uniformly to the food?

2. If added to an ingredient such as flour, will the nutrient be stable during the anticipated shelf life of the ingredient?

3. What effect does the nutrient have on processing of foods?

4. To what extent is the nutrient stable during processing of the food?

5. To what extent is the nutrient stable during subsequent storage of the food?

6. What effect does the nutrient have on the quality and consumer acceptance of the food?

7. Is the nutrient biologically available from the food?

I have not included cost of adding nutrients to foods, because this is part of economic and not technical feasibility and will be discussed in detail by the next speaker. But economic feasibility is more than just the cost of the nutrients being added. If adjustments in formulations or processing to overcome adverse effects of adding nutrients increase finished product costs, then economic considerations may override technical feasibility considerations. Therefore, in many cases, it might not be possible to separate technical from economic factors.

I would like to review briefly, with examples, the seven items listed above which may impact on the technical feasibility of adding nutrients to foods. This discussion is not intended to be all-inclusive, but - hopefully - will serve to alert you to similar situations which may occur in potential, specific cases. Many of the examples are a result of the work of the Inter-Industry Committee which examined the technical feasibility of implementing the 1974 recommendations of the NAS for the expanded fortification of cereal products.

In the vast majority of specific cases, the Inter-Industry concluded that it was technically feasible to add the nutrients recommended by the NAS to cereal-grain products. In some cases, the technical feasibility evaluations uncovered problems which were ultimately solved through additional research.

1. Can the Nutrient be Added Uniformly to the Food?

Enrichment of flour at the mill with iron, thiamin, riboflavin and niacin has been a common practice for many years with no apparent problems in achieving and maintaining uniformity during processing and distribution. Several studies (2, 4, 10) have been conducted in recent years to confirm that selected vitamins and minerals can be added uniformly to a flour mill stream with currently available equipment and that segregation will not occur during pneumatic conveying and subsequent bulk or bagged shipping.

Studies were carried out with both the current standard enrichment blends and the expanded blend proposed by the

The results of these studies with wheat flour and milled products were all positive: nutrients were added unifor and no segregation occurred during handling and shipping

One common method used to enrich rice is to add a simula rice kernel containing blended nutrients to 199 real ker of rice. Although it should be possible to uniformly ad the NAS proposed nutrients to rice, the large volume of calcium and magnesium required might necessitate the add of two simulated rice kernels to 198 actual rice kernels instead of the current ratio of one to 199 (4).

2. If Added to an Ingredient Such as Flour, Will the Nutrient be Stable During the Anticipated Shelf Life of t Ingredient?

There are really two considerations here: stability of nutrient itself and stability of the ingredient to which the nutrient is added.

Storage time is not expected to affect stability of miner but minerals and storage time might interact to affect st bility of the ingredient. An oft-cited example of this t of interaction is the effect of chemical form of iron on flavor development of flour. Ferrous sulfate has been thought to cause off-flavor development in flour stored f extended periods particularly under conditions of high te erature and humidity. In fact, the final report of the I Industry Committee stated, "Wheat flours packaged for lon term shelf life or subjected to elevated temperatures and humidities cannot have ferrous sulfate as the iron source Iron source for fortification of these flours must be red iron or any other iron source which will not contribute t differences in organoleptic properties" (10). This concl sion was based on the best available information at that time.

However, recent unpublished data indicate that ferrous su fate may be an acceptable source of iron enrichment of fl at least under certain conditions.

Vitamin stability has been found to be a problem in a few specific instances. Some losses in vitamin A, folic acid vitamin B_6 and pantothenic acid were found when wheat flo was treated with chlorine after vitamin addition (10). A

number of other flour treatment agents were found to have no effect on these or other vitamins (thiamin, riboflavin and niacin). It is possible that addition of the vitamins after treatment of the flour with chlorine would eliminate the losses.

Vitamin A activity in corn flour and corn meal was reduced during extended storage of these products (10). The Inter-Industry Committee recommended that this problem be corrected by adding at least 20 percent overage of vitamin A.

3. What Effect Does the Nutrient Have on Processing of the Food?

As mentioned previously, the baking industry was generally supportive of efforts in the early 1970s to increase the level of iron in enriched flour and bread. However, a technical feasibility problem was quickly encountered: when the higher level of iron was added as ferrous sulfate in the production of continuous mix bread, the beneficial action of $KBrO_4$ was essentially neutralized and bread of poorer quality resulted. A number of laboratories hastily conducted research on the problem and several solutions were proposed (1, 3). One involved increasing the bromate level and the other called for adding the ferrous sulfate and bromate at different stages in the bread making process.

A lesson was learned from this experience: don't assume anything; demonstrate technical feasibility before committing to a change! Minor ingredients can have effects far beyond what their use levels might indicate.

4. To What Extent is the Nutrient Stable During Processing of the Food?

There is considerable published literature available on the stability of nutrients under a variety of conditions of time, temperature, humidity, pH, etc. This is a good background information and serves well as a guide to what to expect in actual situations. However, most of these published data cannot substitute for data generated from food products under real or simulated commercial conditions.

In order to illustrate this potential problem, I would like to cite the information provided by the cookie and cracker industry to the Inter-Industry Committee (10). Results of research conducted by this industry showed significant losses of some vitamins during baking:

·20-56 percent of the vitamin A in all products tested

·60 percent of the thiamin in chocolate sandwich cookie

·25 percent of the riboflavin and 10 percent of the nia in saltines

·14 percent of the vitamin B_6 in oatmeal cookies

Many of these nutrient losses may be unique to cookies crackers because they are processed at relatively high eratures to a low moisture content. The high pH of the chocolate sandwich cookies was probably largely respons for the loss of thiamin in this product. I would suspe that the long fermentation time used in saltine producti might have had something to do with the loss of riboflav and niacin in this product.

The point is that it is important to know the fate of nutrients during processing of foods, particularly if la claims are to be made concerning nutrient content of the

5. To What Extent is the Nutrient Stable During Subsequ Storage of the Food?

The loss of nutrients during storage of a food is restri to certain vitamins, since minerals would not normally b lost. Loss of vitamins would depend on a number of fact including susceptability of the vitamin to chemical chan time, temperature, packaging, etc. For example, let me cite research results of the cookie and cracker industry

·10-30 percent loss of most vitamins during storage of saltines

·10 percent loss of vitamin A during storage of chocolat chip cookies

·10-25 percent loss of some vitamins during storage of oa meal cookies

Obviously, the loss of nutrients during storage of foods involves a number of factors and can only be accurately assessed by proper testing.

6. What Effect Does the Nutrient Have on the Quality and Consumer Acceptance of the Food?

The answer to this question probably concerns bakers and other cereal processors more than all the other questions combined. And, rightly so. Any changes in product

haracteristics which reduce consumer acceptance and consumption of cereal products hurt both the food processor and the consumer who receives significant amounts of many nutrients at current levels of consumption of these products.

ffects of certain nutrients on product characteristics are eal, although sometimes subtle. It is the subtle change hat is most dangerous, because it is so easy to overlook, articularly to the untrained.

A few examples will help explain.

Slight flavor differences were detected in side by side comparisons of hot farina enriched according to present standards of identity and product fortified according to the NAS recommendations (10).

The NAS recommended calcium level caused an undesirable increase in viscosity of cooked corn grits (10).

The addition of magnesium, and perhaps zinc, at the levels proposed by the NAS affects the flavor, grain, color and crumb firmness of bread (4, 10).

Some of these problems have been or might be solved through processing or formulation modification. In fact, several solutions to the adverse effects of magnesium on bread quality have been suggested (5) and subsequently demonstrated in commercial practice.

7. Is the Nutrient Biologically Available from the Food?

t goes without saying that in order for the addition of a utrient to a food to achieve the intended goal of improving he health and well-being of the consumer of that food, the utrient must be biologically available. A number of factors ffect the physiological absorption of a nutrient during igestion. Two important factors are chemical form of the utrient (particularly minerals) and interaction with other ngredients or components of a food. Processing can have a ajor impact on interactions between nutrients and other ood components.

t should also be emphasized that "natural" is not always "better". For example, researchers at Oregon State University studied the bioavailability of vitamin B_6 in several ypes of bread: whole wheat, white and white bread enriched ith B_6 (4). Adult males, ages 21-35 were used as subjects.

Results indicate that vitamin B_6 was not as available f whole wheat bread as from white bread or white bread en with B_6. No explanation was given for the differences, apparently the effects of other components were factors the reduced absorption of the naturally occurring vitam in whole wheat bread.

The Nutrition Group at the American Institute of Baking others) have done considerable work on factors affectin bioavailability of mineral nutrients.

Bioavailability of iron has received considerable atten It is well-known that chemical form and particle size o reduced iron affect bioavailability. Other components o food can affect iron bioavailability and high fiber ingr dients have been particularly suspect. However, all hig fiber ingredients do not reduce iron absorption. Levels α-cellulose or microcrystalline cellulose of up to 30 pe cent (flour basis) did not reduce iron bioavailability i white bread (7).

In a study of ten commercial variety breads, iron bioava ability was found to vary from 32 to 80 percent of the availability of iron from ferrous sulfate (8). These results suggest that ingredients such as wheat bran, soy flour and vegetable flour (but not purified cellulose) i fere with the availability of iron. The magnitude of int ference was unrelated to the amount of phytate phosphorus dietary fiber. This suggests that the nature of the comp involving fiber and phytate may be more critical than jus the levels of the suspected interfering components.

In another study, the bioavailability of naturally occurr iron in five different types of Iranian flat breads was i vestigated. The bread making process was found to either improve or not improve availability of iron for reasons which were not explained. These results confirm the com- plexity of the problem and difficulty in extrapolating results from one set of conditions to another.

One final example.

The addition of soy protein ingredients to cookies was fo to reduce the bioavailability of zinc, apparently as a re of the formation of a phytate/zinc/protein complex (9). Similar results were observed when the ingredients for so and zinc fortified bread were tested (6). However, when these ingredients were processed into bread by mixing,

fermenting and baking, the bioavailability of zinc improved appreciably. These results indicate that enzyme activity during bread making breaks down the phytate/zinc/protein complex and releases the zinc for absorption.

It should be obvious from the above discussion that availability to the body of nutrients in a food - whether added or naturally occurring - is a complex phenomenon. Accurate and realistic assessments of the value to the ultimate consumer of adding specific nutrients to specific foods can only be made by appropriate testing.

SUMMARY AND RECOMMENDATIONS

Technical feasibility evaluations involve the study of many factors associated with the potential addition of nutrients to processed foods. However, the ultimate objective of adding nutrients to foods is quite simply stated: to improve the health and well-being of consumers by increasing the amount of nutrients (which are otherwise below minimum levels) absorbed by the body. This implies stability of the nutrient during processing and storage of the food, continued consumption of the food at anticipated levels, and absorption of the nutrient from the food when consumed.

Food processors, government policy makers, and consumer spokespersons can all agree that the appropriate addition of nutrients to foods can be an effective mechanism for improving nutritional quality of diets. I would urge that all who are directly or indirectly involved in this subject work together to insure achievement of the goal.

Therefore, I urge policy makers (legislators and regulators) to work cooperatively with the food industry to evaluate the merits of modifying current practices of adding nutrients to foods. The widespread production of enriched bread and other cereal products came about as a result of voluntary efforts on the part of the food processing industry and acceptance of these products by consumers. I suggest that any change in current enrichment practices be done on the same basis. Let the food industry demonstrate technical feasibility, let the products be marketed on a voluntary basis along side of current products and let the consumer decide which product will be purchased.

Finally, the AACC Council on Fortification was established to encourage the appropriate addition of nutrients to foods at both the domestic and international levels. The Council will

do this by offering advice, counsel and expertise on re
It is our hope that legislators, regulators and others w
are committed to the same goal will take advantage of th
vast storehouse of knowledge which is available through
Council.

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NUTRIENT ADDITION TO FOODS - MECHANICS AND ECONOMICS

B. Borenstein

Hoffmann-La Roche Inc.
Nutley, N.J. 07110

Dr. Vetter and I have attempted to avoid duplication of material as much as possible in our presentations, but it is essential in discussing the mechanics and economics of fortification to mention the related problems of product acceptability, nutrient stability, and bioavailability. In this presentation fortification will be used as a generic term for the addition of vitamins, minerals, and amino acids to foods for the purposes of nutritional improvement. This presentation will not attempt to summarize the extensive review literature on the technology of fortification (Borenstein 1974, 1975, 1979).

The technology of fortification with any and all micronutrients involves the same basic considerations: selection of the in-process point of addition of micronutrients, the mode of addition, and selection of the market forms of the micronutrients. These decisions are dependent on a number of interrelated factors including stability, bioavailability, organoleptic problems, safety, cost, production practicality, and the reliability of the addition system. Fortification projects cannot be run efficiently unless all these factors are considered before lab work is initiated.

STABILITY

The more labile vitamins which can present stability problems in food processing and storage are vitamins A, D, B_1, , pantothenic acid, B_{12}, and folacin. Although serious degradation of these vitamins can be encountered under specific adverse conditions, measures can be employed to minimize losses. These include protective coating of individual vitamins, the addition of antioxidants, control of temperature, moisture and pH, and protection from metal, light, and incompatible metals during processing and storage. By applying proper technology and using suitable manufacturing

overages of added vitamins based on a critical evaluat
stability data, it is possible in almost all food appl
tions to obtain and maintain desired label claims for
normal shelf life of food products.

In all fortification projects an input or overage above
label claim is essential to ensure compliance after pro
sing and storage. Even in the case of the most stable
min, niacin, an overage of approximately 10% is require
because of imperfect distribution in its addition to ma
products and inherent analytical errors in assaying mic
nutrients in foods. Few of the vitamins can be assayed
food concentration levels with an accuracy better than

The most unstable vitamin, vitamin C, can be successfu
used to fortify most foods with reasonable overages, if
modern process technology is available. For example, s
baking causes particularly high vitamin C losses, mecha
systems have been successfully engineered to spray bake
bread on cooling lines with vitamin C solutions. In oth
words, there are technological solutions to most specifi
in-process stability problems.

However, there are some unsolved problems. Two examples
specifically pertinent to the cereal industry. (1) The
first successful technology for fortification of rinse r
sistant rice with vitamin B_1, niacin, and iron was devel
in 1946. However, methodology for adding vitamin B_2 wit
coloring the rice yellow after cooking and, therefore,
making it unacceptable to most consumers has still not b
developed 35 years later. (2) B_1 is unstable in high pH
foods, e.g., chocolate cake.

Another interesting problem is fortification of canned v
tables with micronutrients which is complicated by the d
tribution of the nutrients between the food particles an
the canning liquid. There is potential waste and potent
deception in having the water-soluble vitamins drained a
lost when the consumer drains the vegetables. It is les
difficult to fortify frozen foods. A spray solution or
pension of nutrients can be applied to the frozen food p
uct directly at the packaging line and losses during fro
storage are moderate for most of the vitamins. Losses d
ing home preparation are also moderate as long as the we
ratio of cooking liquid to solids is low and controlled,
which is the case for many frozen products. Vitamin C r
tention in frozen, boil-in-bag vegetables is excellent a
home preparation.

A comment with respect to frozen foods and cost of fortification. In 1971, FDA suggested nutrition quality guidelines for frozen convenience dinners, emphasizing minimum levels of five critical micronutrients. This resulted in considerable argument on variability of the micronutrient content of the major food components of these dinners, the difficulty of proper sampling and the cost of frequent vitamin analyses. The ingredient cost of adding the five micronutrients at the required level to 10,000 dinners is approximately $0.70; the analytical cost for a single assay of these five micronutrients is approximately $70. The fortification cost is unusually low in this case because the label claims (vitamin A 500 U; B_1 0.17 mg; B_2 0.21 mg; niacin 3.3 mg; iron 2.1 mg/dinner) specified are quite low, but fortification in general is a low-cost process.

Minerals

The technical problems in mineral fortification pertain more to organoleptic deficits and to bioavailability than to stability problems of the compounds per se or to methods of incorporation in foods. Since relatively large amounts of calcium and magnesium salts are required to obtain nutritionally significant levels of these minerals, the selection of suitable compounds must include not only concerns about their bioavailability and their cost, but must also consider their potential for shifting the pH of the food, introducing chalky flavors, opacity, sediment and/or color changes. The potential mineral problems of fortifying white bread according to the NAS/NRC 1974 guidelines were studied and solved through the efforts of AIB and commercial bakers.

Although the nutrient addition levels of the trace minerals, iron, and copper are low, their potential to catalyze oxidation of fat, vitamin A and vitamin C requires that the selection of suitable iron and copper compounds be tempered with concern for possible organoleptic changes and effects on shelf life. Despite the ongoing excellent research on iron bioavailability the issues are far from resolved. It is crucial that any standards promulgated on the bioavailability of iron compounds used in fortification be consistent with the practical aspects of fortification. For example, it would be inconsistent to promote spinach, which has an iron bioavailability of 2%, as a good iron source and simultaneously limit added iron sources to a minimum bioavailability of 5%.

Expanded Cereal Fortification

The NAS/NRC 1974 expanded cereal grain fortification pro
al (six vitamins + four minerals) has a total ingredient
cost of approximately $0.25/100 lbs of flour. A premix
the eight micronutrients excluding the magnesium and cal
cium with appropriate overages for baking costs approxi-
mately $0.20-0.25/100 lbs.

Premixes are the preferred way to fortify almost all pro
ucts. Premixing avoids the need for inventorying a large
number of ingredients each of which requires careful wei
ing. Premixes improve dispersion of the micronutrients a
save considerable quality control analytical work on the
finished foods. This last point is extremely important.
The suitability of premixes in continuous metering of B_1,
B_2, niacin, and iron in the wheat flour industry has been
thoroughly demonstrated in the published literature and 4
years commercial practice.

Starting in the middle sixties a minus 100 mesh stabilize
dry vitamin A product was developed specifically for over-
seas donation flour at the request of USDA. Specificatio
were set to insure performance at the mill as well as sta-
bility in flour, cornmeal, enrichment premixes and stabili
during baking of white bread, chappaties and tortillas.
This product has also been used commercially in many dry
foods and has been used in premixes and published studies
determining technological feasibility of the NAS/NRC 1974
proposal (Cort 1976). Most recently an extensive study wa
run and published by Parrish et al (1980) confirming that
this stabilized dry vitamin A does not segregate or classi
in transport and pneumatic conveying of wheat flour forti-
fied according to 1974 proposals.

Other vitamin problems in fortifying according to the NAS/
NRC proposals are minimal and bread is now commercially
available from several bakeries which conforms completely
to the 1974 vitamin and mineral guidelines.

Fortification in Less Developed Areas

In less developed areas of the world the preparation of pr
mixes and continuous feeding into flour streams is also fe
sible as long as there are large enough central mills to
justify both the purchase of mixing and feeding equipment
and the training costs involved. This is not complex tech
nology, but it does require personnel training.

Fortification is obviously more difficult in situations where grains are ground at the village levels. Inexpensive feeders have been developed for this purpose, but the limiting factors are probably logistics and education. The most practical solution to the village problem may be the addition of simulated grain kernels containing concentrated levels of micronutrients to the grain prior to grinding. A similar approach is to infuse grain with the desired nutrients. USDA, for example, developed successful technology for infusing whole wheat with lysine. This involved scratching the surface of the kernels by a light pearling treatment, then soaking in a 35% lysine solution for three hours at 160°F draining and drying. The kernels absorb 10-15% lysine and when blended with untreated wheat are undetectable. Nestle sells amino acid fortified bouillon cubes in Nigeria.

These techniques are technologically feasible, but obviously not as convenient or simple as premix addition to flour. In specific situations vehicles such as tea, sugar, and MSG have proven convenient and useful fortification carriers. Sugar has been successfully fortified with vitamin A in Central America. The technology for fortifying tea with vitamin A was developed by Brooke and Cort (1972) and scaled up by USDA/AID in India. Technology is usually not the limiting factor in fortification programs.

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FDA FOOD FORTIFICATION POLICY

Peter Barton Hutt, LL.M.

Covington and Burling
Washington, DC

Fortification of food with vitamins, minerals, and protein has been a major part of national nutritional policy since 1940. Food fortification programs have been credited with eradicating many once-prevalent nutritional deficiencies and raising the overall nutritional quality of the American diet.

Nonetheless, nutritionists have begun to express concern that the value of food fortification is not sufficiently recognized or understood by government officials and the public. Apprehension has grown that the Food and Drug Administration (FDA) decision in 1978 against increasing the level of iron fortification in flour and bread could reflect a change in policy that would inhibit future progress in food fortification.

Viewed against this background, the food fortification policy promulgated by FDA in the Federal Register on January 25, 1980, is a welcome development (1). The policy establishes principles for the rational fortification of food and encourages industry to fortify food in accordance with these guidelines.

AMERICAN MEDICAL ASSOCIATION COUNCIL ON FOODS AND NUTRITION

The American Medical Association (AMA) Council on Foods and Nutrition provided the first strong impetus in this country for the fortification of food products. In the early 1930s it endorsed the addition of vitamin D to milk and of iodine to table salt. In March 1936, the AMA Council announced the first general policy on food fortification in this country. It stated that fortification should be reserved for exceptional cases where there is convincing evidence of a need for enhanced amounts of the vitamin or mineral in the general food supply and the food to be fortified is suitable for fortification.

In December 1938, the AMA Council issued a statement

opposing indiscriminate food fortification but supportin
addition of vitamin D to milk, vitamin A to substitutes
butter, iodine to table salt, and calcium and iron to ce
grain products. The statement also encouraged the resto
tion of vitamins and minerals to preprocessing levels, wh
led to experimentation with the addition of vitamins to f
and bread.

NATIONAL ACADEMY OF SCIENCES
FOOD AND NUTRITION BOARD

In mid-1940, the National Academy of Sciences (NAS) established a Subcommittee on Medical Nutrition (which la became the Food and Nutrition Board) at the request of the National Defense Advisory Commission. Although the subcom mittee was established primarily to provide advice to the government on war-time food and nutrition issues, its stro support of food fortification had a significant impact on food industry.

FEDERAL FOOD, DRUG, AND COSMETIC ACT

The Food and Drugs Act of 1906 contained no authority establish food standards. The Federal Food, Drug, and Cosmetic Act of 1938 (FD&C Act), which replaced the 1906 a did give FDA broad authority to establish definitions and standards of identity for any food. Moreover, the 1938 act also authorized FDA to issue, by regulation, labeling requi ments for all foods represented for special dietary uses in order fully to inform purchasers about the vitamin, mineral or other special dietary properties of those foods. Shortl after the 1938 act was enacted, FDA began to exercise this authority.

In November 1941, FDA promulgated its first regulation governing label statements about the special dietary proper ties of food. These regulations established the requiremen for label declaration of the "minimum daily requirements" f various vitamins and minerals, which remained in effect for years.

In August 1940, FDA announced public hearings to estab lish a standard of identity for flour. The enrichment reco mendations of AMA and NAS were presented at the hearings, a the industry joined in supporting flour enrichment through standards. This marked the beginning of the FDA regulatory approach to food fortification that has endured to this day The enriched flour standard became effective on January 1, 1942. Fortification of bread and rolls became widespread b cause of industry's voluntary use of enriched flour and lat because the War Food Administration required fortification.

1943 FDA FORTIFICATION POLICY

As a result of increased interest in fortified food, FDA issued a statement in July 1943 setting forth the agency policy on addition of nutritive ingredients to food (2).

The FDA stated fortification is an implicit promise to consumers that the fortified food contains sufficient vitamins and minerals to make a substantial contribution to the nutritional welfare of persons eating that food in customary amounts. Thus, FDA said that the kinds and quantities of nutrients to be added to the food must be determined in the light of the following: specific nutrient deficiencies in the diet of the general population and of significant population groups, the place occupied by the food in such diets, and the suitability and effectiveness of the food as a carrier of those nutrients. FDA stated that most natural foods contain a wide variety of nutrients in significant amounts and adequate nutrition is better assured through the choice of natural foods than through reliance on food fortification.

FDA did endorse restoration of nutrients in those staple foods from which significant quantities of nutrients are lost during processing. The agency also agreed that, in some instances, nutrients may be added at higher than restoration amounts, or to fortify unrefined foods, where appropriate to correct deficiencies if the fortified food is an efficient carrier.

The 1943 FDA statement of policy has never been revoked and remains in effect to this day.

POST WORLD WAR II FORTIFICATION DEVELOPMENTS

Following World War II, food fortification continued to flourish. The enriched bread standard, consideration of which was postponed during the war, was reopened and promulgated in final form in May 1952. By this time, state laws had made enrichment of flour and bread mandatory in 26 states. FDA also established standards of identity for various other enriched products, such as dairy products, macaroni and noodle products, and margarine.

1962 PROPOSED FDA RESTRICTIONS

By the early 1960s, FDA began to be concerned about the possibility of overfortification of food. As a result, FDA proposed the first major revision of its special dietary food regulations since they had been promulgated in 1941 (3).

The proposed regulations would have permitted the use in fortified food or any other dietary supplement only of those

nutrients recognized as both essential and of significar dietary-supplement value in human nutrition. FDA specif cally listed 12 nutrients that fell in this class and th ranges within which they would be considered appropriate supplementation. Eleven other nutrients were recognized essential but not appropriate for supplementation becaus deficiency symptoms are induced only under experimental ditions. FDA sought, in this way, to contain the growin interest in food fortification and dietary supplement products.

DEXTRA DECISION

At the same time FDA also sought to institute legal forcement action in the courts to stem the tide of increa food fortification that the agency considered irrational. 1961, FDA brought legal action against New Dextra Brand F tified Cane Sugar, which was fortified with some 19 nutri FDA contended that the product labeling was misleading be cause it either stated or implied that the American diet deficient in vitamins and minerals, that Dextra would sig nificantly improve the diet, that Dextra was significantl more nutritious than other sugar, and that all the vitami and minerals in the product were present in nutritionally significant amounts.

The District Court ruled against FDA on all these charges. The court said that the real basis of the govern ment's objection to the sale of fortified sugar was the notion that sugar is not a preferable vehicle for nutrient supplementation. The court stated that the implementation of sound nutritional principles, and the encouragement or discouragement of the consumption of particular foods in accordance with these principles, are matters for consumer education and not for legal enforcement pursuant to the FD&C Act. It concluded that FDA has no authority to prohi the sale of food in the marketplace, even if the agency is not in sympathy with its use, because the FD&C Act does no vest in FDA or any other federal agency the power to deter mine what food should be included in the American diet. O appeal, the lower court was affirmed. (United States v. 1 cases . . . "New Dextra Brand Fortified Cane Sugar," 231 F Supp. 551 (S.D. Fla. 1963), aff'd 334 F.2d 238 (5th Cir. 1964).

FDA APPROACH OF 1966

The comments on its June 1962 proposal, and the court decision in the Dextra case, convinced FDA that an even mo restrictive regulatory approach was necessary to stem the

:ide of indiscriminate food fortification and dietary supple-ent products. In June 1966, FDA published its final revision of the special dietary food regulations that contained pro-visions significantly changed from the June 1962 proposal(4). Specifically, two standards of identity were added to the 1962 proposal: one to standardize dietary supplements of vitamins and minerals and the other to standardize a limited number of foods that may lawfully be fortified. FDA listed eight classes of foods that would be permitted to be forti-fied and the specific nutrients which could be used in each.

More than 300 objections were filed to these regulations, which prevented FDA from putting them into effect. FDA then convened formal public hearings on the regulations that ul-timately were held over a period of two years, during 1968-1969.

WHITE HOUSE CONFERENCE

As often happens, a political event intervened to change public attitudes about food fortification dramatically. In response to charges about hunger and malnutrition in America, President Nixon convened a White House Conference on Food, Nutrition and Health in December 1969. The Conference report made several recommendations for fortification of existing and new food products to meet national nutritional needs. The thrust of this report was in direct opposition to the 1966 approach of FDA.

FDA POLICIES OF THE 1970S

The White House Conference represented the death knell of the restrictive approach to food fortification proposed by 'DA in 1966. In its place emerged a number of new regula-:ions, based largely on food labeling requirements rather than 'igid standards for nutrient composition.

Nutrition Labeling

A 1973 regulation stated that the addition of any ·utrient to a food, or the use of any nutrition claim, auto-natically requires full nutrition labeling in the standardized :ormat established by FDA.

Definition of "Imitation"

FDA defined an "imitation" food as a product that is designed to substitute for a traditional food but which is nutritionally inferior. If the substitute product is forti-'ied in order to make it nutritionally equivalent (or

superior) to the traditional food, it is no longer an i
tion. This action discourages debasement of the food s
and requires nutrition labeling for any substitute food
is fortified with a nutrient.

Establishment of Food Names

Rather than attempting to adopt comprehensive stand
of identity for new fabricated foods, FDA issued regulat
establishing descriptive names for these products. In m
instances, the characteristics that FDA has determined t
important in describing these foods include their nutrit
composition.

Nutrition Quality Guidelines

FDA issued general principles governing the establis
ment of nutritional quality guidelines, together with on
specific guideline governing frozen "heat and serve" din
A nutrition quality guideline prescribes the minimum leve
range of nutrient composition appropriate for a given cla
of food. A product which complies with a guideline may s
on the label that "this product provides nutrients in amo
appropriate for this class of food as determined by the U
government." A product within the class governed by the
guideline, which has been fortified above the level provi
in the guideline, must bear a label statement that "the
addition of _____ to this product has been determined by
U.S. government to be unnecessary and inappropriate and d
not increase the dietary value of the food." Additional
dietary guidelines have been proposed by FDA but have bee
held in abeyance pending promulgation of a comprehensive
fortification policy.

Fortification Outside Standards of Identity

FDA had long taken the position that addition to a
standardized food of any nutrient prohibited by the stand
made the product illegal unless it was labeled as an imit
tion. In the 1970s, FDA reversed this policy and permit
the marketing, as nonstandardized foods, of the following
fortified versions of foods for which standards exist tha
not permit the fortification involved: enriched macaroni
fortified protein, tomato juice enriched with vitamin C,
enriched raisin bread. The FDA no longer regards these p
ducts as imitation foods.

FINAL SPECIAL DIETARY FOOD REGULATIONS

Beginning in 1973, FDA published the final special dietary food regulations resulting from its 1968-1969 hearings. Because of perceived restriction on vitamin-mineral pills, the health food industry repeatedly challenged these regulations in court and persuaded Congress in 1976 to enact a new Section 411 of the FD&C Act to limit FDA authority over these products. In this law, however, Congress was careful to limit FDA authority only with respect to vitamin-mineral products in tablet or capsule form, or in liquid form intended for ingestion in drops or similar small units of measure. Thus, these new restrictions on FDA do not limit its authority over food fortification.

1974 FDA PROPOSED RULES ON THE ADDITION OF NUTRIENTS

In its final special dietary food regulations of 1973, FDA explicitly rejected the 1966 approach of listing, in a standard of identity, all foods to which any nutrient may lawfully be added. The agency concluded that this approach was unnecessarily inflexible in light of developing knowledge about nutrition.

In place of this restrictive approach, FDA proposed general rules governing the addition of nutrients to foods(5). The proposed regulation consisted basically of two parts: a statement of principles governing the addition of nutrients to food, and provisions designed to enforce those general principles. It is this proposal that led to the new FDA food fortification policy promulgated on January 25, 1980. This proposal, while considerably more flexible than the FDA's 1966 approach, was still regarded by many as too restrictive and enforcement orientated. The final 1980 policy statement, summarized later in this article, addresses many of these concerns.

1978 FDA DECISION ON IRON IN BREAD

After FDA proposed its food fortification policy in June 1974, it made its most visible, and misunderstood, decision respecting food fortification during the past several years: it declined to approve the proposal to double the permitted level of iron in enriched bread.

The White House Conference had recommended that the level of iron in enriched bread be substantially increased in order to combat widespread iron deficiency. Therefore, a petition was filed with the FDA to amend the agency's food standards

for enriched flour and enriched bread. In December 1971 proposed changing the level of 8.0 to 12.5 mg of iron pe pound of enriched bread to a single level of 25 mg of ir per pound, thus doubling the permitted amount of iron. corresponding change also was proposed for enriched flou After reviewing the public comments, a final regulation adopting those changes was published in October 1973.

Because several physicians objected to increasing t iron content of enriched flour and enriched bread, a for public hearing was held to consider the matter in 1974. 1977, FDA issued a tentative decision withdrawing the pr posed increase in iron fortification, and in 1978 the ag issued a final order confirming that decision (6,7).

The FDA tentative decision said that the proponents increased iron fortification must prove that it is safe a has nutritional utility, i.e., nutritional value for a ta population. FDA concluded that, on the basis of the spec evidence produced at the hearing, these elements were not adequately proved. FDA did not at any time state or impl that increased iron fortification was in fact unsafe or c no utility. Rather, the agency simply concluded that the available evidence did not prove safety and nutritional utility.

FDA found that the facts presented during the hearin showed that a small fraction of the U.S. population is deficient in iron, that no good studies exist showing tha dietary augmentation of iron will be effective in supplyi the needs of those particular people, that present eviden is inadequate to assess whether mild iron deficiency anem is harmful, and that additional fortification of bread ha not been proven to be an efficient way of reaching those segments of the population that need iron supplementation

FDA said the hearing record demonstrated that there diseases caused by excessive iron intake and that the evi dence fails to show whether dietary iron will or will not aggravate those diseases. FDA concluded that, as a regul tory agency responsible for all consumers, it must procee cautiously, especially because clear proof of the need fo and utility of increased iron fortification is lacking.

After prominent nutritionists who strongly supported food fortification expressed concern about the tentative decision, FDA issued its final order. FDA said that it h no intention of discouraging further research in the area iron fortification. In particular, the final order speci cally stated that this was an extremely narrow decision, based solely upon the unique facts presented, and that a future decision based upon different evidence might well decided the other way.

FDA also stated that, in the future, adequate studie the need for additional food fortification would only be

required where serious concern is raised about the safety of the nutrient involved, the food in question is a widely eaten product, and the needed amount of the nutrient is in dispute. FDA emphasized that it was the existence of the scientific dispute among reputable experts in the field that resulted in the decision in this particular case. Thus, the widespread apprehension of nutritionists that this decision foretells severe restrictions in food fortification is unfounded.

1980 FDA FORTIFICATION POLICY

On the basis of the comments received on the June 1974 proposal as well as the information gathered from the hearings on food labeling and nutrition conducted in 1978, FDA issued its final food fortification policy in the Federal Register of January 25, 1980 (8).

The agency stated that, in the absence of a unifying set of principles, random and arbitrary fortification of some foods is likely to occur. This may result in overfortification with some nutrients which are inexpensive and technologically simple to add, and underfortification with others. Promulgation of standards of identity for fortification of all foods would be unnecessarily inflexible in light of developing knowledge about nutrition and changing food forms and consumption patterns. Accordingly, FDA concluded that a statement of general principles respecting food fortification is an appropriate approach.

The June 1974 proposal had incorporated specific enforcement mechanisms to assure compliance with the proposed food fortification principles. FDA had proposed that any fortified food that did not comply with the proposed policy would be required to bear the following statement: "The addition of ____ to this product has been determined by the U.S. government to be unnecessary and inappropriate and does not increase the dietary value of the food." Claims that a product had been fortified would have been prohibited unless the fortification constituted at least 10% of the U.S. RDA in a serving.

In the final policy statement, however, these labeling restrictions were eliminated. The agency stated that a substantive rule covering all aspects of food fortification and labeling of fortified food is not feasible at this time. Thus, the final 1980 policy statement represents only guidelines that are not directly enforceable by FDA as legal requirements.

The FDA policy states that food fortification can be an effective way of maintaining and improving the overall nutritional quality of the food supply. The purpose of the policy is to preserve a balance of nutrients in the diet in order to

avoid either overfortification or underfortification. policy specifically notes that it is based on U.S. diet practices and nutritional needs and may not be applica other countries.

The statement of policy emphasizes that FDA consid inappropriate to fortify the following foods: fresh pr meat, poultry, or fish products; sugar; or snack foods as candies and carbonated beverages. The agency states consumers do not consider snack foods to be components meals or as a nutritional contribution to the diet, and neither the public nor the scientific community has con snack foods to be appropriate carriers for added nutrie given the general adequacy and diversity of the nationa supply.

The policy statement establishes the following five principles for appropriate food fortification:

To Correct Dietary Insufficiency

FDA states that any of 22 listed nutrients may appr priately be added to a food to correct a dietary insuffi recognized by the scientific community to exist and know result in nutritional deficiency disease. Although food manufacturers are free to apply this principle on their they are urged to contact FDA before implementing fortif tion on this basis.

In the past, FDA has of course used this principle establishing standards for enriched food, nutrition quali guidelines, and other similar regulations. The preamble the policy statement recognizes that in the past the addi of specific nutrients to food has served to correct defi- ciency conditions in large segments of the population. states that such public health measures may continue to prevent nutrient deficiency diseases where sufficient in mation is available to identify a nutritional problem, de affected population groups, and designate suitable foods act as vehicles for the added nutrient.

To Restore Lost Nutrients

FDA also recognizes that it is appropriate to add a the 22 listed nutrients to a food to restore it to nutrie levels representative of the food prior to storage, handl and processing, but only if the nutrients have been lost "measurable amount." FDA defines this amount as at least of the U.S. RDA per serving. If any nutrient restoration done, all nutrients that are lost in a measurable amount to be restored.

To Balance Calories With Nutrients

In perhaps the most controversial portion of the policy statement, FDA states that addition of nutrients is appropriate to balance the vitamin, mineral, and protein content with the total caloric content of the food. For purposes of implementing this principle, FDA adopts a standard daily caloric intake of 2,000 kcal as contrasted with 2,800 kcal that had been used in the June 1974 proposal.

Three important limitations are placed upon this principle. First, in order to avoid fortification of foods that make a trivial caloric contribution to the diet, this principle applies only where a serving of the food contains at least 40 kcal. Second, each of the 22 listed nutrients must be added in the amount necessary to achieve nutrient balance. (Vitamin D, iodine, and protein are optional because of the relatively narrow range of safety for vitamin D and because iodine and protein are already consumed in sufficient quantities in the average diet.) Only the amount needed to achieve the proper nutrient density, and not any greater amount, is to be added.

In adopting this principle, FDA rejected a number of other suggestions. The agency concluded that nutrient density should not be tied to protein content because it would not allow for the fortification of protein-free products and also would encourage the unnecessary addition of protein to food. The suggestion that fortification on a nutrient density basis should be permitted for individual nutrients, rather than for all listed nutrients, was rejected on the basis that this would be contrary to the objective of total nutrient balance.

In response to a comment arguing that vitamin A, thiamin, riboflavin, and niacin should be added to potato chips in proportion to calories on the basis of dietary shortages in children, FDA said that this type of fortification would come under the first principle as a public health measure to correct for specific nutrient deficiencies and is not a justification for applying the nutrient density principle randomly to individual nutrients.

To Avoid Nutritional Inferiority

Under current FDA regulations, a new food that resembles, and is intended to substitute for, another food must be labeled as an "imitation" if it is nutritionally inferior. It is common practice to add nutrients to new substitute foods in order to avoid the "imitation" label, and this principle encourages that practice.

To Comply With Other Regulations

Existing standards of identity, nutrition quality g lines, and regulations establishing common or usual nam for food contain various provisions on the nutrient cont of the food involved. This principle permits nutrient addition to comply with any such regulations.

Although the enforcement provisions in the June 197 proposal have been eliminated, the final 1980 food forti tion policy states that labeling statements on fortifica must not be false or misleading and must otherwise compl with the FD&C Act. It then goes on to provide examples acceptable label claims for food fortified in compliance the five fortification principles. Food restored with nutrients may state that fact. Food fortified in accord with the nutrient density principle may be labeled as fo lows: "Vitamins and minerals added are in proportion to caloric content." The agency also states that the terms "enriched," "fortified," "added," and similar terms may a be used interchangeably, thus abandoning its long-time ef to enforce separate definitions for those terms.

FUTURE OF FOOD FORTIFICATION

Food fortification has played a major role in nation nutrition policy. Regulatory concern about food fortific tion has been caused both by the desire to restrict forti cation to those situations where it is demonstrably usefu and to avoid fortification where it could cause legitimat concern about public safety. Unduly restrictive regulato approaches to fortification by FDA have now been abandone and are unlikely to return unless unwarranted fortificati becomes prevalent in the future.

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5. 39 Fed. Reg. 20900 (June 14, 1974).
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WHAT WE'VE HEARD AND WHAT IT MEANS

Robert O. Nesheim

Quaker Oats Company
Chicago, IL

It is my pleasure to be here and try to summarize what we've heard. I am not going to review all of the presentations and make specific comments relative to them, but I am going to talk about what I think has come out of this workshop and where we go from here.

First of all, I think we should consider what the objective was in coming together. In the material sent to us, the objective of this workshop was stated as, "to form a basis for the development of policies regarding the appropriate additions of nutrients to grain-based foods. These policies will be based on the assessments of nutritional quality of current diets, health status of populations, technical feasibility, and regulatory requirements."

First I would like to comment on the legislative and regulatory aspects, some of which were discussed by Peter Hutt today. From a legislative standpoint, it is apparent that we really cannot expect to see anything of major consequence. We haven't seen anything for many years. I don't think that we should anticipate that there is going to be any legislation that will affect current policies concerning fortification of foods. Congress has clearly spoken on the regulatory aspects of vitamin/mineral supplements in telling the FDA to keep hands off in that particular area; but when they have done that, as Peter Hutt stated, they have chosen not to take away FDA's authority as it relates to nutrient addition to food products. So if we can judge by the past, the future from a legislative standpoint is pretty clear. The Congress isn't going to do much to change the current situation.

I think Peter Hutt summarized the regulatory status extremely well, and I am not going to try to go back and repeat what he said. However, I wish to make some comments concerning what the industry might do and perhaps should not do as we try to be responsible. In 1980 the FDA issued

guidelines for nutrient additions to foods. Peter Hutt mentioned the criteria FDA stated be used in judging whet nutrients should be added to foods. These essentially we if there is a dietary deficiency or a public health need, restoration of nutrients which may be lost in processing, comply with regulations such as food standards and so on, maintenance of the nutritional quality of a food, and the addition of nutrients relative to the caloric content of food. These are the five criteria which FDA's guideline spells out. As Peter Hutt mentioned in his discussion thi morning, these are not regulatory requirements - they are only guidelines, and one is not compelled to comply with them, although there may be reasons from a public image standpoint that the industry would want to act in accordan with the guidelines.

In looking at where we stand relative to these guide-lines, and also to some of the prior actions that have bee taken in evaluating fortification of cereal-grain products, we find a considerable amount of reference to the 1974 publication by the Food and Nutrition Board of the Nationa Academy of Sciences. It so happens that I chaired the task force that looked at and developed the guidelines for the nutrient additions to the cereal-grain products in 1974, an as a result I am rather conscious of the data or the lack thereof that we had for developing the recommendations. Think back to 1974 and look at the kinds of data that were available to a committee in making this evaluation. We had data from the 10-State Survey, which was not a national nutrition survey but was a survey which was oriented to reach special groups which were suspected to be in possible nutritional need. The HANES I survey was really only underway at that time--we did not have the results from that, and we had the USDA 1965 Nationwide Food Consumption Survey information. That is essentially the information th we had from which to draw our conclusions.

In 1981 the Food and Nutrition Board published a repor on assessing changing food consumption patterns and relatin these to nutritional status and health. I chaired that committee also, in which the methodologies that have been used in assessing food consumption in the U.S. were reviewe In addition the committee evaluated whether there were methods by which one could relate food consumption patterns to the nutritional status and health. In the course of thi activity I was made particularly aware of the limitations that we have in the data bases currently available, e.g. th HANES data and the Nationwide Food Consumption data, in being able to project from that data to actual nutritional problems. There is real difficulty in relating the kinds o information that we are getting to an assessment of

nutritional status and its possible impact on health. For those of you who may not have seen it, I think you will find this report interesting reading. It is available from the NAS for about $16. This report is worthwhile for anyone interested in fortification and looking at the problems of assessing nutritional status in the U.S. population.

The discussions that we have had during the last day and a half have raised some very interesting questions. On the issue of cereal grains as a carrier of fortification, we certainly have a long and historical basis where cereal grains have been considered appropriate carriers for nutrients. There have been the enrichment standards for a wide variety of cereal-grain products for many years. So historically there is a strong basis for using cereal grains as a carrier, and there is also a strong basis for saying that it is technically feasible to do so. In terms of the evaluations made of the 1974 NAS recommendations, I think it is clear that while there were some minor technical problems, in general it was technically feasible to carry out the recommendations made at that time. Also, if you look at the cost of adding the nutrients in that recommendation, it is not costly to carry out. Therefore, in terms of the cereal-grain-based foods industry being an appropriate one to provide a carrier for nutrients and delivering them to the public, this recommendation appears to be important and appropriate.

In terms of the public health aspects of the need for the expanded fortification, I think we have to take a look at the data available to us today. Peter Hutt mentioned this morning that there are no restrictions under FDA's regulations that would prohibit the cereal industry from taking any reasonable position on fortification. However, to achieve acceptance among the nutrition community and the public, there are some aspects that need to be taken into consideration in any fortification program. I think we should raise some questions: Have we identified a nutritional problem that is really a public health problem on the basis of the data available? From the HANES I and the Nationwide Food Consumption Survey, and the HANES II data that will soon be available, can one identify specific nutrient-related public health problems? If so, can one identify who in the population group has this problem? There was a discussion today that mentioned a population segment, younger women, where calcium, magnesium, iron, and B6 appear to be nutrients of concern. It is important to recognize that while the calculations made from the available dietary intake data may suggest a problem, it is difficult to generate any specific public health data that indicate there are significant problems. One of the difficulties is that

we frequently use the RDA as a standard or as a requiremen and calculate possible deficiencies from these. Also, the information from these surveys does not take into account the consumption of vitamin and mineral supplements, which know is a very significant factor in the American diet.

Thus one needs to examine very carefully whether or n there is a deficiency in dietary intake which is reflected as a particular public health problem. Then I think one h to determine whether the fortification of cereal-grain products will reach the appropriate population. If, for example, the young female teenager is the most vulnerable one, is this population going to eat a sufficient amount o cereal-grain products, fortified at prescribed levels, to make an adequate contribution to their dietary intake of these nutrients? I think this analysis needs to be made before reaching a conclusion as to whether this should be done. Given these kinds of questions, what remains to be done in the decision-making process to provide direction to the cereal-grain industry?

I think there are some things that need to be done if acceptance of fortification is to be achieved in the scientific community. I think as you talk to different people in the nutrition community you find about three leve of interest, as in any population distribution. There are those highly supportive of fortification, others who haven' thought much about it and are benign on the whole subject, and others who are very much opposed to the concept of fortification. There is probably a standard bell-shaped curve which applies to the nutrition community's attitude toward fortification.

I think it is useful to have an analysis of public nee for fortification as a part of getting acceptance by the public. As Peter Hutt pointed out this morning, from a regulatory standpoint there are no real inhibitions about t industry fortifying products. Acting as a responsible indu try, however, it is important to look at the preceding aspects as they relate to need, so the industry responds responsibly. If it does act responsibly, this will help maintain the current environment in which the FDA is not ve interested or not concerned with economic issues and the Congress is not concerned with food fortification as a practice.

Obviously, if the industry does not act responsibly this could lead to a change in policy, whether it be regula tory or legislative. Therefore, I think it is useful to examine carefully the HANES II data which will be available soon, look at the Nationwide Food Consumption Survey data which is available from the USDA, and again examine the dat in the same way it was done for the NAS report in 1974, to

see if we can identify a nutritional problem. If so, who has the problem, what is the food consumption pattern of the group that has the problem, and will fortification of cereal-grain products address the problem.

This is the direction I see the industry taking from here. I suspect that the kinds of data now available for making a decision are not going to be greatly different than were available when the committee looked at this in 1974. There is probably going to be about the same level of confidence in the information today as in the early 1970's. I do think it is a necessary thing to do, and it could strengthen whatever position the industry might decide to take relative to fortification of particular food products.

One of the difficulties the industry had in implementing recommendations from the 1974 NAS report was that the industry was interested in changing the standards of identity of many cereal products. From the discussion with Peter Hutt this morning, I think it is apparent that would be a very difficult thing to do. The FDA is not interested in taking any initiative on this. The FDA does not want to get into the type of hearings that are required to change food standards. So if you wish to market cereal products which incorporate fortification different than that permitted in the standards of identity, it is going to require some innovative labeling and marketing approaches to do it. There are no legal impediments in doing that if properly done. I think that speaks to the U.S. situation.

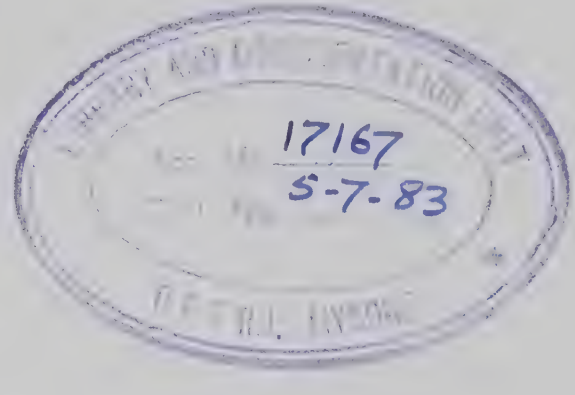
Just a few comments on the international aspect, as this was discussed and was an important topic of this meeting. The situation in the international arena is quite different from that of the United States. We are dealing with many populations whose nutritional problems and needs are frequently very different than we face in the U.S. Very often the primary nutritional problem of inadequate caloric intake is ignored and the concern runs to specific nutrients, such as vitamin A. As was pointed out in the discussion, where there is one significant deficiency it is likely there are multiple deficiencies but one which is overriding. The problems in the various countries are often those of distribution. How do you get nutrients to a population that you identify as being in need? In lesser developed countries where the people who have real serious need are often on the marginal end of the money economy, or essentially outside of the money economy, how do you reach them? How do you reach them with fortified products? How can they be reached with fortification of grains when most of the grains are processed at the village or home level as opposed to a central processing system? It is very difficult, as it was pointed out, to add fortification at the village level and certainly

in the home.

So in many of the international areas, when considering a specific area of fortification, frequently products other than grains must be considered. There have been some innovative approaches taken, such as the use of sugar, salt, MSG, tea, and other products, as alternatives to cereal grains as a means of providing specific nutrients to solve nutritional problems.

The PL 480 programs and other programs for the distribution of grain and other commodities in overseas programs involve decisions that are largely economic. Money is allocated for these programs, and the countries involved tend to make their decisions more on economics or political considerations than on the basis of nutrition. Therefore, I think it is difficult to come in with commodity programs which involve fortification when trying to reach a broad base of the population. The more successful of the supplemented or fortified grain product programs are those that are targeted to the requirements of a narrow, specific population segment, in which food is distributed through some controlled feeding situation. It is very difficult to meet nutritional needs of a major population group by broad commodity fortification distributed to a large population. It is usually not economic, in terms of the amount of money that is available, to provide the nutrients in this manner. Also, the distribution problems in many of these countries are difficult to overcome. So the international situation relating to fortification of cereal-grain products is quite different from what we face in the United States.

I think it has been an interesting day and a half. Where we are is clear. Where the cereal-grain industry goes from here in terms of cereal fortification depends to a great extent on the initiative and the innovations of the cereal foods processing industry.


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